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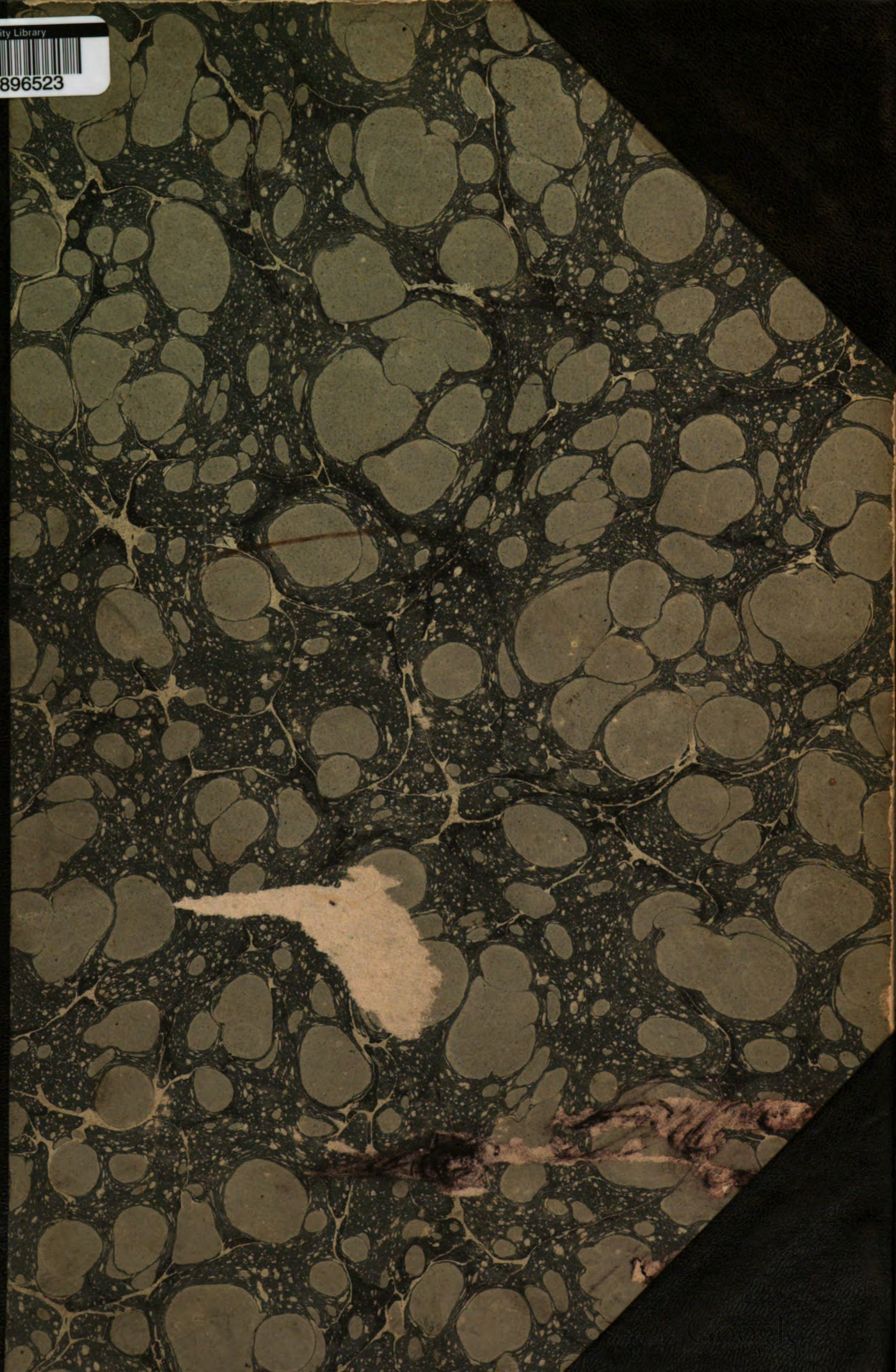

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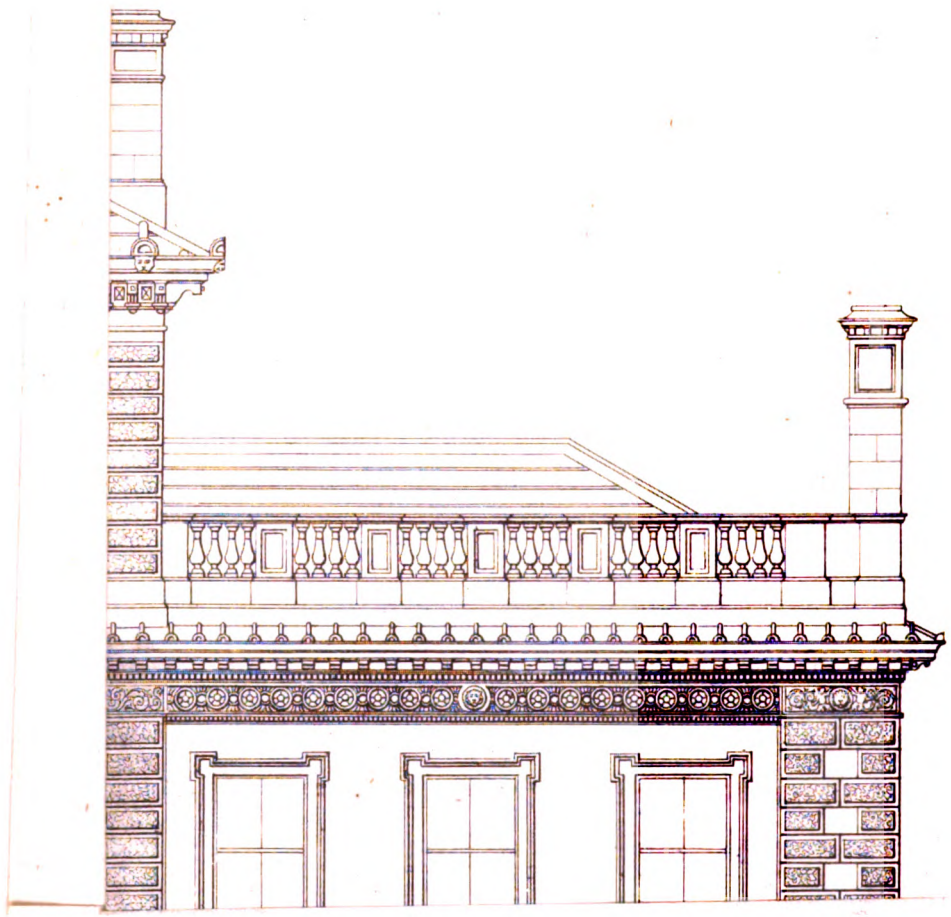

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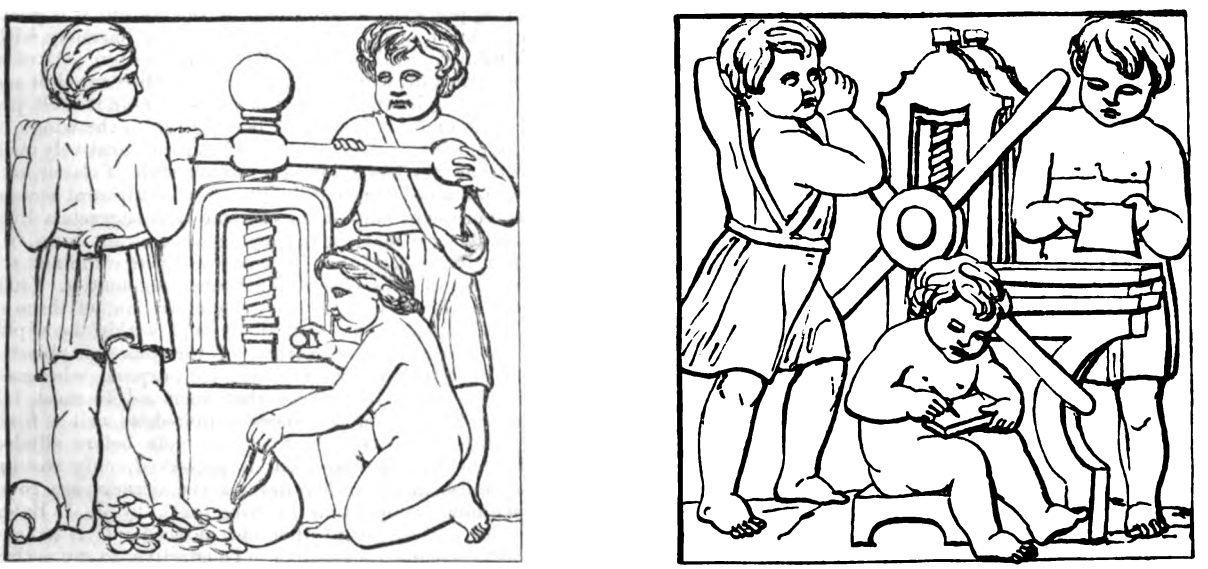
THE

CIVIL ENGINEER AND ARCHITECT'S JOURNAL.

COMMERCIAL BANK OF SCOTLAND, GLASGOW.—DAVID RHIND, Esq., *Architect.*

(*With an Engraving, Plate* I.)



PANELS TO REPRESENT THE GOLD AND PAPER CURRENCY OF SCOTLAND, DESIGNED FOR THE FRONT OF THE COMMERCIAL BANK OF SCOTLAND, GLASGOW.

THIS building, of which we give an elevation, is in progress as a place of business for the Commercial Bank of Scotland. The style adopted is sufficiently shown by the engraving, and needs no description. The rustic work is vermiculated, and gives massiveness to the building throughout, but more especially to the ground floor. The keystones are enriched with bold heads, and the two panels shown on the ground floor are filled with sculptural groups in full relief—the one representing die-stamping, as emblematic of the metallic currency, and the other printing, to represent the paper currency, the combination of the two being peculiar to the banking system of Scotland. The figurative embodiment of this idea of the architect's was entrusted in the modelling to Mr. Thomas, of London, who also furnished the models for the heads on the keystones. The two annexed wood-cuts show the manner in which the subject has been treated.

The three sculptured pediments over the first floor windows are intended to give appropriate richness and effect to the building. That in the centre contains Commerce, supported by Navigation and Locomotion, as representing foreign and inland trade, and these figures are respectively supported by others bearing fruit, corn, bales of goods, &c., the whole being composed with a view to the illustration of the objects of the building, as well as a satisfactory filling up of the spaces. The pediment on the right hand, or at the east end as the building faces the south, is filled with figures representing Edinburgh, supported by Art and Science, and that on the left hand bears corresponding figures, representing Glasgow, supported by Trade and Manufactures. The sculpture in these three pediments was designed by the architect of the building.

The interior arrangements contain all the requisite accommo-

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dation for the business of the bank. The centre door leads into the outer saloon, from which enters the telling room, where the public business of the bank will be carried on. This room is upwards of 40 feet square, and lofty in proportion, with a spacious cupola above, supported on a wide circle of caryatides. The whole telling room is richly decorated. The other rooms are to be respectively appropriated to the managers and other office bearers of the establishment, and there are large cash and book safes, with every modern improvement for security, and an extensive fire-proof library for the books of the bank on the sunk floor.

There are dwelling-houses on the upper floors for three of the office bearers in the bank, entering from the side doors; and the rest of the apartments at each end which remain unappropriated will be let off for chambers.

The stone used is from Binney Quarry, near Edinburgh.

The architect of the building is Mr. David Rhind, Edinburgh, the President of the Royal Scottish Society of Arts, and the contractors for the principal part of the work are Mr. David Rae and Mr. John Shennan, of Edinburgh.

THE ARCHITECTURAL EXHIBITION.

Among the recurring winter exhibitions must now be reckoned this, which has just taken possession, for the second time, of the Gallery of British Artists in Suffolk-street, Pall Mall. On former occasions we have strongly advocated the claims of such an undertaking, and set forth the advantages which it necessarily promises both to the profession and the public; as also by means of the "material" department, to practical artificers, who are thus enabled more freely and clearly to set forth their inventions, and ensure for them a calm and fair consideration.

Whatever were the merits of last year's exhibition, it has manifestly been outstripped by that of the present, both in respect to the drawings on the walls and the models, &c., which crowd almost inconveniently the two rooms allotted to them. When it is remembered also that the committee had intimated their intention to exclude for the future all works which had previously been exhibited, this liberal response is the more gratifying, for there were not a few of the truest and most active friends of the cause who feared lest so bold a decision might prove premature; and, however sanguine they might be as to the ultimate attainment of such an object, that there was a danger of a temporary check by undue precipitancy.—The fact, however, that nearly 600 new drawings have been considered worthy of a place is a proof that such apprehensions were misplaced, and is, we opine, a mark of progress. To say that the general aspect presents that showy character which large or elaborate performances in massive frames of necessity insure, would not be correct, but, in place of "stars" which had usually been outshining one another in other spheres, there is an excellent display, possessing the charm of novelty, and not overdecked by extrinsic aids. Now this is really as it should be, provided the general public, for whose benefit in a great measure such institutions are formed, are sufficiently trained to appreciate and admire art in its more simple garb. It is most true, as has been remarked in an influential quarter when noticing the present exhibition, that in the Royal Academy the buoyant feeling of curiosity which has inspired the visitor on his entering the first picture-room, has been gradually weakened in his tour through the second and third, and by the time he has reached the architecture it is pretty well exhausted. No wonder, then, that the pale formal drawings and little white models scarcely attract a glance from eyes already dazzled by gazing on gaudy hues, and consequently that in the majority of instances one quits the room with a repulsive, rather than favourable opinion of the subject.

But if it be granted that the public are ready to welcome genuine *architectural* drawings, then, in the series under consideration, is there a tendency to this proper stamp.—Still it is much to be wished that more plans had accompanied the designs, especially in the cases of competition drawings, in which, after all and before all, a good plan is the desideratum. While touching on this subject we must repeat a regret we have before expressed, that the hanging committee did not contrive so to arrange the competition drawings that a better comparative estimate might be formed of their merits. For, say what we may against the system on which competitions are too generally conducted, it is this class of work that is more particularly calculated to stimulate the abilities of candidates, and test their judgments in the right disposal of sites, as well as the most suitable application of materials. Each adventurer knows also the conditions to which he has to submit, with the intended outlay; so that in a fair field and no favour, we repeat, there is no better means of developing talent and ingenuity than by open competition, supposing always that the acting judges are qualified for their office.

In noticing the contents of the several rooms, we shall pursue to some extent our own plan of classifying the different works, beginning with the chief buildings of the day.

Birmingham and Midland Institute.—This competition, though limited to a selected few, has been one of the most important of the year, and, as our readers are doubtless aware, was decided in favour of Mr. E. M. Barry, views of whose design have been given in more than one periodical. The site chosen for the building (close to the magnificent Town Hall) rendered it a matter of question as to the best character to be given to the proposed edifice, and each of the competitors, in the drawings they have here shown, has adopted a different idea. In the instructions given, the area and destination of the several apartments was minutely specified,—the whole building being subdivided into three departments, the general, the industrial, and the fine art;—each to be kept distinct, and to have a separate entrance, but with facility of communication throughout. Expenditure strictly limited to 20,000*l.*, including architect's commission and clerk of the works. The first on our list is (81), by Mr. I'Anson, a really architectural drawing, in which each part bears impress of careful study, and is capitally delineated. The design appears to be a good one, and is accompanied by general plans. The elevation is in three stories, of which the middle is the chief. This has a continuous semicircular arcade, springing from pilasters, the spandrels being filled in with circles. In these latter, as well as in the tasteful corbel or eaves-course, colour is sparingly introduced. Along the chief entablature are inscribed the names of various men of science, while some bas-reliefs, in a low attic over the three central bays, follow out the idea. The basement appears the inferior part of the design; it is poor, and its succession of raised panels is scarcely in harmony with the general feeling. Adjoining is Mr. James' design (85), of which two geometrical drawings (401, 402) may be discovered in another room. Judging by the latter, the masses are not well proportioned, far too much importance being given to the wings; while the centre building is a little recessed and comparatively insignificant. The author has followed a stricter style of classic art than is now usual, and has profusely introduced sculptural accessories. The shape of the ground at the extreme ends suggests a difficulty of treatment, here met by employing a quadrant form, which, above the basement story, becomes an open columnar screen, reminding one of some of Sir John Soane's ingenuities. (403), by Lockyer and Martineau, is very plain Italian, of three equal stories, besides basement, and, albeit kept within the stipulated outlay, most certainly unworthy of the place or object. No sculpture or other device indicates its purpose, whereas it is precisely in works like these that such aid is most telling. This design differs from the others exhibited, as well as from the one selected, in the treatment of the ends before alluded to. Here the true rectangular form is preserved, only receding to suit the limits; in the other designs the corners are rounded. The remaining competition drawing (421), by J. J. Bateman, forms quite a contrast to that last noticed. It is too equally loaded with ornamental features to be effective, to say nothing of the apparent extravagance of its cost. A light columniated screen projecting, forms a covered entrance, and its outer cubes are carried up to the level of the next story by coupled columns, with an open arch in each face,—an empty and very barren device. Surmounting the extreme ends of the building are two "Greenwich" cupolas.—There is no clue to the internal arrangements.

Oxford University Museum.—This competition was also adjudicated a few months since to Mr. E. M. Barry, who appears to have entered on the matter with a determination to go in and win. There were at least four designs furnished by him, portions of which he has forwarded to this exhibition. (31) appeared lately at the Royal Academy (with small plans, now stripped off), and we presume is now shown merely as a pendant to the others. In (32) the same plan, apparently, is Gothicised into a kind of Tudor-domestic elevation, the eight-columned

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central portico being converted into three four-centred arches, with another returned, and large octagonal bays or oriels fill in the width of the wings between angle buttresses. The assumed garb, however, does not fit well; it still remains a *classic* design. In divers parts of the rooms we find Mr. Barry's other four drawings explanatory of his schemes. What a pity they were not kept together! In wandering from one place to another the interest is lost, and their value all but negatived. Messrs. Papworth's design (50) is faithfully Vitruvian, but needlessly bare and meagre. Any good effect which it might in reality produce would be owing to the disposition and broken outline of the masses. (51), by E. Ellis, is quite a palatial conception, save in the campanili, towering so loftily at each of the angles, and for which one is at a loss to divine the purpose, unless for effect. It is wholly of one order (Corinthian), which is continued also along the flanks. In the intercolumniations are two ranges of windows, and a projecting portico in the middle of each front breaks the severity of the lines. The inner court (Qy. museum) is roofed with glass on the ridge-and-furrow principle. (95) is one of the six selected designs; its author, Mr. H. B. Garling, has adopted a "flowing" Gothic type, having traceried windows labelled and crocketted. The general effect is sombre nevertheless, and very tame. A continental style of roof, showing boldly, and crowned with open metal cresting, helps the general outline; but the little central turret is unworthy of its position. The drawing is carefully outlined. One other design (108) for this building is quite Palladian, in which the errors of the style are more conspicuous than the elegancies. There is a stupendous central tower formed in stages by groups of cupolas, and a large sprawling pediment gives ample space for a sculptured tympanum. The glass roof behind forms in this, also, an external feature.

Warehouses and Street Architecture.—Among these we find views of some of our noble City improvements, as well as of those in Manchester. (22), is one of the large blocks in Cannon-street West, erected for Messrs. Devas, Minchiner, and Routledge, from designs by Messrs. Griffith and Dawson. In comparison with some of its neighbours, this does not appear pre-eminently good; still, as a correct if not bold conception, it is very creditable. (303), "Offices erecting in Turnwheel-lane, Cannon-street, by Messrs. I'Anson," is still more ordinary. Mr. J. J. Cole exhibits some "Offices" being erected by him in Throgmorton-street and Shorter's-court, in an outline drawing (447), which lacks character for so large a building. By a photograph (508), Mr. Lockyer exhibits a view of the premises erected for Messrs. Heal and Son, in Tottenham-court-road, where colour is introduced externally by means of Minton's tiles and Magnus' slate. It is a good specimen of the class. Mr. Gray, we observe, keeps to his old material—*brick*, red and white—which, in his villas especially, he turns to good account. His contributions are numerous and effective. Of his Tottenham Church we shall have to speak presently. Among provincial exhibitors in this department the name of Mr. Walters will be recognised. The noble piles with which he has enriched Manchester are some of the best structures of the kind in England, though the "Commercial buildings" seen in (107), seem scarcely up to his usual standard. Mr. Brakspear has, in (194), an "Elevation of a Warehouse erecting in John Dalton-street, Manchester." (55), another Manchester warehouse, is stated to be 300 feet long, by 90 returned, and 115 feet high. It has six stories, and is to be faced with Yorkshire polished stone. The cost, without land and fixtures, 45,000*l.*! (63) is a richly tinted drawing. The style adopted by the architects is the kind of Venetian, in red and white brick, now becoming so general. In (54 and 318) are other designs from the same sources; but Mr. Druce's has little to recommend it.

Infantry Barracks.—This competition being still in suspense, none of the designs could be forwarded to this exhibition; but Mr. C. J. Allen, in (65), sends a "first sketch." It represents a range of buildings three stories in height throughout, in which the chief architectural effect is sought by arranging the windows into groups, some of three, others five or seven in each; all have semicircular heads. The Militia Barracks, Great Yarmouth, by J. Brown (67), look well; they are in red brick, with white dressings. No plan is attached.

Monumental Memorials.—It being intended to erect on the Beacon-hill, at Bodmin, a monument to Sir Walter Raleigh Gilbert, Bart., designs were advertised for, to which numerous architects responded. It was, we believe, ultimately given to an engineer! The design before us, by Mr. F. W. Porter, seems as if of brick with stone quoins, and on a stone pedestal. It is square on plan throughout, and terminates pyramidally like some of the Italian towers. In a niche on one face of the pedestal is a small statue of the general. (214), by H. A. Darbishire, was possibly prepared for the same; but a more unfortunate attempt could scarcely be made. It is a florid Gothic affair, of four open sides, each filled in with window tracery, and over which is a crocketted gable. The corners consist of octagons, which terminate in pinnacles; and the whole is crowned by a spire, enveloped in a mist of panelling and smaller pinnacles. (542) is a "Design for a Peel Monument," by J. Mitchell,—very opposite in character to the last, but little better. The style chosen is Tudor, in general form an octagon, each side breaking forward on the lower story into two faces, which terminate in ogees against the upper stage.

Taunton Assize Courts.—Mr. Lamb's perspective (37) is an exceedingly clever design, by no means showy, but good. It is Italian in style. The centre consists of a decastyle recessed portico (Ionic), the architrave being flatly arched to each intercolumniation, showing the arch joints and a marked keystone: portions of the surface are rusticated. The cabling (if so it may be called) of the columns is curious. Very little ornament is introduced, the chief being a continuous foliaged frieze. Behind a low open attic, which surmounts the building, rises a large flat dome. Of Mr. E. M. Barry's design there are two drawings, unluckily separated. (4) is the external perspective, and (471) includes a plan of principal floor, and a view of the Criminal Court. The style is late Gothic, and not a little resembles that of the New Houses of Parliament, especially in the entrance porch.

Sheffield School of Art.—For this several designs are exhibited; (143), the first in the catalogue, is paltry, much surpassed by (252), where there is much to praise. It was proposed on bas-reliefs to represent the three arts—sculpture, architecture, and painting; and as representative men the busts of Flaxman, Wren, and Reynolds, were suggested to occupy the projecting brackets between the ground and first stories. These brackets appear too coarse, and to disturb the general simple effect. (343), by local architects, Messrs. Weightman, Hadfield, and Goldie, is again not so good; while (436), is an absurd Louis Quatorze idea, and (437) little better than a neat Elizabethan dwelling-house.

Cemetery Chapels.—Owing to the recent alterations in legislative enactments, there is now a great demand for these buildings, and consequently the exhibition is all but surfeited with designs; there are more than thirty drawings, for the most part, we are sorry to see, of very moderate pretensions; and many, such as (80, 238, 248, 258, 267, 310, 346, and 384), absolutely bad. In others there is a tendency to overdo the consecrated chapel especially, by either adopting a complete church form, transepts and all, as in (5); or raising an ambitious tower and spire, as in (227). These buildings always appear to us most appropriate when simple and solemn in character, while a small bell turret will usually suit the size of the building, and be found quite sufficient for practical purposes. When cleverly managed, too, it may be made a valuable feature in the design, though sometimes too attenuated, as in the drawing just referred to (5), and at others, as in (174), made over large for its position: (here, by the by, it is also faulty in drawing). Messrs. Gabriel and Hirst's design for Chepstow (310) has a disposition to both these errors. Among those of a better description we may enumerate Messrs. Cooper and Peck's "*Lodges*" to accompany their design (5 and 6); Mr. E. B. Lamb's (36 and 333), exceedingly clever and original, though rather heavy in parts; also his (317), adapted to the plan of a parallelogram and an octagon. This latter, a very rough drawing in pencil, is effectively handled. The roof is shown of the "chapter-house" type, slated, and crocketted up the angles. (62), Mr. T. D. Barry's Atherton Cemetery, is a pretty landscape-view merely. (149), by Mr. R. Kitton, embraces two interiors,—one of early English character, the other of Tudor, both very common-place. A plain but good polygonal roof in the former of these is the only particular worth noticing, unless it be that the ceilings in both are indicated as blue, with stars, &c. (174), by Arthur Billing, is on the two-and-two principle, with entrance gateway between the church and chapel, which are precisely alike. The arch soffit to the gateway is unfortunately shown to be cusped. Messrs. Walter and Blackett propose, in (227), a metal lich-gate between their lodges. Mr. R. Rowe's four drawings (228, 248, 258, and 267) are peculiar from the accommo-

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dating dodging of their plans. (241) is a "Design sent in competition for an episcopal and dissenters' cemetery, chapel attached." This latter Mr. Pedley makes "Perpendicular," and connected, chancel-like, with the church, which is early English! The chapels which Mr. Hall is erecting at Bridport (375 and 379), are in better taste than most exhibited; and so is (476), by Mr. G. W. Lloyd. There is some novelty also in Mr. C. Baily's designs for those at Newark-on-Trent (417 and 418).

Church Competitions.—There are several of the competition drawings for the new one at Peterborough, for which Mr. Ellis, of Fenchurch-street, is the selected architect. The first in the catalogue is (124), by Messrs. Deane and Hill, showing a plain edifice of Northamptonshire type; but, withal, too heavy looking, A second is (176), with an interior view in another room (208). The author, Mr. A. Bailey, has embodied some very good features, but has perhaps carried unbroken breadth of surface to too great a degree for good effect. Externally, the belfry stage is the best treated; and, internally, the plainness of the architecture is partly relieved by bands of colour built in the walls, and the alternately-coloured stones of the arches throughout. (204) and (416), exterior and interior, by Mr. F. G. Lee, are both unsatisfactory; the former, from the miserable thinness of the walls, and consequent wiriness of the details; and the latter, from its prevailing clumsiness, in the tower, especially, whose low pyramidal roof, starting but a little above the nave ridge, suggests whether it may not be intended as a temporary covering only. In (451), Mr. Murray comes out in full force as a picturesque designer and skilful draughtsman. The several parts combine exceedingly well. (461), by Gritten and Weller, is of very fair merit; but so much more ornamental than other designs, that it is difficult to imagine that the instructions as to outlay could have been properly attended to.

We do not discover the approved design for St. Luke's Church, New-road (by Mr. J. Johnson); but Mr. Teulon and Mr. Joseph Clarke have sent views of their designs. That by the former gentleman (142), is strikingly novel, and has some excellent points about it. In some of the features continental examples are traceable. The south end here shown (for such the site makes the only visible part), is an octagonal one, with high gables to each face, behind which springs an octagonal steeple ingeniously treated. "The construction suggested for this church was of brick. The spire to consist of a framework of iron, roofed in with slate, having bands of rough plate-glass,—the spirelets of wrought iron, galvanised, and enriched with gold." Mr. Clarke's drawing (159) presents no fresh ideas whatever, except in some trifling bits of detail, and these are no improvement. It is, on the whole, of orthodox "Decorated" character.

Our notice of the several remaining subjects, as well as the interesting department of materials, &c., must be deferred till next month. Meanwhile it should be the aim of all, who wish well to architecture and the arts, to repair to the Galleries, not merely to countenance the undertaking, but as a means of obtaining an abundance of suggestive information. To give greater facilities for this the price of admission is reasonable,—for season tickets especially, which will admit also to the series of lectures about to be delivered in the rooms. The exhibition is to be open till the 23rd of February.

On the evening of the 18th ult. a conversazione was held to inaugurate the Exhibition, when a very numerous company assembled, including many of the distinguished men of the day, as connected with the fine arts,—the professors of architecture at the Royal Academy and at University College, Sir C. Barry, R.A., &c., &c.

THE STATUE OF CHARLES I., CHARING-CROSS.

For some little time repairs—not *restorations*—have been going on at the pedestal of this statue, which were rendered necessary by its growingly insecure state. A new Portland slab has been fixed immediately under the horse, and a better method employed of screwing the metal plates to the stonework than before. Iron bond, too, has been laid all round the inside of the base, and through stones with cement are liberally used, so that the whole is now firmer than it ever was. The statue proves to be partly solid and partly hollow. The repairs are being done by Mr. John Thomas, under the direction of G. Gilbert Scott, Esq., A.R.A.

BARRACK ACCOMMODATION FOR THE ARMY.

SIR—Seeing that a committee is now sitting on the above all-important subject, and that the public mind has been so wrought upon by pungent articles on "Billeting in Beer-shops," and on *Barrack Accommodation*, and the *want* of it, I had hoped that some abler pen would at least have touched upon the matter *practically* before this.

The Report of the Parliamentary Committee on Barracks, "pursuant to an address of the House of Lords, ordered to be printed 3rd of August" last (and No. 314, Parliamentary Papers), but which as yet has not had a very general circulation, is of much importance, from the valuable collection of evidence it puts before the public—chiefly, however, as regards our *present* barrack accommodation.

It is not *now* my desire to go in detail into that report, of eleven pages, or the evidence relating to it; but I wish to bring to notice, without further delay, some omissions that possibly might have been supplied, and to observe on old-fashioned and not very desirable arrangements proposed to be continued, which can be avoided, without increase of expense or alteration of outline, whatever plan may be adopted.

1st, then, as regards provision against fire, except the ordinary and obvious recommendation that the powder magazine should be fire-proof (page x), I see none.

2ndly, in page viii, I observe the old custom of placing the soldiers' heads (in the dormitories) to the windows and walls, assumed as that to be adopted. The words are—"*With eight feet between the ends of the beds*, supposing them *arranged on opposite sides of the room*." Whereas military men accustomed to active service know from experience the inconvenience and confusion likely to arise, and which has arisen, from such a disposition, when men have been or may be called up suddenly to repel an enemy, or on any other emergency.

To meet this objection, as well as the other disadvantages attending it, it will be found on inquiry—indeed, it is demonstrable—that another arrangement with the same breadth of building is attainable, this confusion avoided, and much greater safety from fire ensured, better ventilation obtained, and the soldiers' comforts greatly increased, by placing their heads to a low centre wall or partition, and by giving to each pair of men the wall and window, which would be in this way opposite the "ends of the beds," with racks for their arms and accoutrements, the window to read or to work in, and at their bed-head small presses to place their spare clothes and necessaries in.

Each floor of a building so arranged—say 120 feet long, by the breadth (22 feet) proposed, would thus hold two "squads" or fifty men, and repeated at the other side of a common hall or day-room, of same breadth, with stairs at the rear, each level, or flat would contain what, I believe, is a desirable number—a full company of *one hundred* men, who could thus be mustered and told off while still under the roof. I shall not now enter into the advantages for *ingress*, *egress*, or *inspection*, in this way afforded, as, if not taken up by others, I may trespass on your next *Journal* with a few diagrams explaining what, I fear, I have here but too briefly alluded to, but shall at once proceed to make a few observations on

CAVALRY BARRACKS.

If removing the soldiers' heads from the walls and windows be an advantage, the benefit to horses of such a change cannot be over-estimated—indeed, it is universally admitted and adopted amongst civilians, even with *single* stables, as an improvement on the old *close system* of heads along an impervious wall, or to windows blowing down on eyes, and heels almost meeting (when horses stand back) across an *undefined*, but too often well *defiled*, neutral ground.

I am perfectly aware that, even on this indifferent system, with such ample space as the committee recommend (page xiii)—stalls 9 feet long, and distance between tails 12 feet—it is possible, with every attention to ventilation and cleanliness, to show very nice stables. But the same breadth of house (30 feet)—if the horses' heads be turned to a centre wall, recessed for racks and mangers, and with ventilating flues carried right up (in the piers between the recesses) to the top of the building—would admit of infinitely more perfect arrangements. The windows and doors would be free as the ventilation, and one side or one stable might actually be burned without involving the rest.

Lastly, in conclusion, of what I fear I have but partly explained. The men, indeed, might be allowed to live in rooms over those

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stables, as recommended by the committee (page xii); as the "NOXIOUS AIR," which the report says it is desirable should be prevented from "rising through the ceilings," would be conveyed away by the flues, as I have said, right up the centre wall; and, accordingly, would not "enter the men's rooms through the windows"—as is notoriously certain on what we may call the tail-to-tail fashion. I am, &c.,

J. W., *C.E.*

P.S.—Although not exactly a part of the subject of *Barrack Accommodation*, I cannot reconcile omitting the opportunity of calling attention to the necessity of having at *all* barracks, tanks, ponds, or reservoirs, with a pressure sufficient to throw water to the top of the highest building. These tanks, were no other means available, could be filled by the exercise—either for pleasure or punishment—of portions of the men; and, as at Cartonhouse a few days since, in case of fire, such reservoir could be kept full, as it was there, by the superfluity of labour usually offering; but generally lost, as at Aldershot, for want of an *efficient* and *established* means of supplying it. J. W.

THE QUESTION OF THE DIPLOMA FOR ARCHITECTS.

SOME years since, an effort was made by several parties to drag the question of compulsory examination and diploma, for the profession of engineers, before the public. At that period the pages of this *Journal* contained some articles, in which we expressed our decided objection to the introduction of an organisation of this description; and we confess that subsequent experience has not induced us to alter the opinions then advocated, nor have the arguments lately propounded in the discussion at the Royal Institute of British Architects shaken our opinion as to the utter uselessness, even if we may not say the positive danger, of such a system.

The real questions to be decided in this discussion are—1st, Is the present unrestricted competition a source of public evil, so great, that it is necessary to adopt energetic remedies for the purpose of combating it; and 2ndly, Would the introduction of a system of examination, and subsequent diploma, effectually protect the public interests from the dangers supposed by the advocates of such examination and diploma to exist?

Now, it is unquestionably true that, under the reign of absolute liberty and unrestricted freedom which prevails both in the engineering and architectural professions, many men enter the ranks of those pursuits who are utterly unfit to discharge the duties they undertake. We have lately been compelled to witness the nomination of men totally devoid, not only of scientific, but even of primary education, to places of influence and profit as government engineers. We have had our common sense insulted by the nonsense of self-cleansing pipe sewers, and gathering grounds pot-piped for a water supply. We have seen the literary and scientific reputation of our country made the laughing-stock of the world, by reason of the bad grammar, the ignorance, and the presumption, to be found in the reports and blue books issued by that most incomprehensible of all public bodies, the General Board of Health, which seems to desire to become, in fact, a new Department of Public Works. We have seen Mr. Ruskin deliberately "snub" all preconceived opinions upon the merits of painters, or upon taste in architecture. We have seen congregations of parsons, yclept Archæological Societies, take upon themselves to reform architecture; whilst our art-patronising Court has employed a builder to design its new palaces, instead of turning to regular practitioners. All this is true; "and pity 'tis, 'tis true." But is the evil we admit thus to exist, in consequence of the ease with which any pretender can dub himself architect or engineer,—is this evil, one fraught with serious evil to society, of a nature, at least, to induce us to imperil the right of any Englishman to earn his livelihood as he likes or best may? We believe that it is not. The folly, jobbery, and nonsense of the recently-created government offices have been discovered by all thinking and intelligent men; the works they executed have proved such miserable failures, that the majority of their former supporters have been compelled to acknowledge that they had but worshipped false gods; and the publications "by authority" have been so ridiculously absurd, that they have materially aided the return of the public to common sense. In art and architecture, the vagaries of Mr. Ruskin, and the retrograde anachronisms of the archæologists, have had their day; and although Cubitt and compo may still be in fashion at Osborne, the public is rapidly learning to appreciate a style of architecture which is both truer and more consistent with our wants, habits, and modes of thought; whilst the rantipole twaddle about Turner and the Pre-Raphaelites is beginning to be treated with the contempt it deserves. The fact is, that a nation cannot for a continuance be deceived: the masses are really, in the long run, of sounder judgment than their would-be guides; and that only retains a permanent hold of the popular mind which is founded on reason and truth. Fashions often do an incalculable amount of mischief; but the fashion of to-morrow, generally speaking, counteracts that of to-day, if no injudicious attempts be made to guide and control public opinion.

It may even be questioned whether, after all, the very licence which prevails in our country in the matters we have alluded to, be not preferable to the deadly apathy or the spiritless routine which prevails in countries more artificially and more elaborately organised. As in the science of medicine, the intruders, the quacks (as they are styled) called homœopathists, have in the end compelled the allopathists to abandon many of the doctrines formerly received without examination, because no regularly educated man dared to think otherwise than the professors of his hospital, school, or college, taught; so in engineering, the bold, impudent assertions of the Chadwickians have made professional men inquire into the reasons for the faith that was in them. Medical men found, when the heat of their struggle was over, that really they had administered in former times too large doses: engineers found also that the house drains made with bricks were neither so convenient nor so economical as glazed stoneware pipes. And although infinitesimal doses were found to be useless in acute diseases, and small stoneware pipes to be unfitted for carrying off the sewerage of large towns built upon low level lands, yet in both professions the very violence of the discussions, and the absurdity of the new doctrines when pushed to the extreme, have done ultimate good, if it were only by proving that from time to time it is necessary to examine the doctrines which appear to be beyond question. There is, in fact, a tendency in every constituted authority to override and enchain the judgment of those exposed to its rule. The balance is only to be obtained by allowing the opposite tendency of our race—our desire to resist authority—a properly limited sphere of action. Liberty must, in a word, counteract authority.

The same remarks may be applied—without any modification, so far as their spirit is concerned—to architecture or to painting. In England we are apt to run wild after "manias;" and most professional men of the present day can recollect the mania for the school of the Adam's, for Sir J. Soane, which gave way in due time to the reign of the Grecian mania. No doubt Grecian architecture is exquisitely beautiful; and he must be sorely deficient in taste, we hold, who can now find nothing but faults in such buildings as the Post-office, St. Pancras' Church, or the Hanover Chapel. But Grecian architecture is bald, cold, deficient in the movement of outline, so to speak, and the play of light and shade required for our climate; and the persons who organised the revolution in public taste, which led us back to the imitation of a national style, so far rendered service, that they diverted fashion from an anachronism unsuited to our skies or our traditions. Their error was in stopping midway. We are no more Englishmen of the mediæval period than we are Greeks of the time of Pericles; and there is quite as much of the *ortodossia de' pedanti* in the blind imitation of what is usually called Gothic architecture, as there was in the slavish reproduction of the monuments of Athens. Architecture does not hold the rank in public estimation—say the advocates for a diploma—which it deserves. Is not this, to a great extent, attributable to the want of an actual, vital appreciation of the wants and habits of our age, by the professors of this noble art? They have become learned copyists—they create nothing. Regularly organised schools, examinations, and diplomas, would in no wise counteract this tendency. Nay, by rendering it absolutely necessary to study in particular directions, it is to be feared that the injurious effects of school traditions will be further increased. The history of painting shows that this is no chimerical danger. Wherever the State has taken the arts under its protection, there they have immediately begun to decay; and this remark is true, whether applied to England, France, Spain, Italy, or Germany, to the ancient or to the modern world; so that the law it implies must be independent of forms of worship, of social organisation, of

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climate, or any ordinary physical causes. Most firmly do we believe that the evil we suspect to be attached to any organisation in these matters, is attributable to the interference it must give rise to in the free exercise of individual powers; and to the rigidity, the petrification of intellect—so to speak—which is the inevitable result of the tyranny of schools. Freedom has its evils and its inconveniences; but, hitherto, these have been found to correct themselves, provided men be left alone to think and act for themselves.

But, if freedom in professional matters at times be a source of evil, from the facility it offers to incompetent men to rush into pursuits they are totally unacquainted with, it is also a source of good, from the ease with which a man with natural genius can force his way into notice. Had it been necessary to have gone through a particular class of studies, or to have obtained a diploma from learned examiners, who would most likely be wedded to the theories of the school in which they themselves were educated, such men as Sir C. Wren or Mansard might have found themselves excluded from the ranks of a profession they so wonderfully adorned. Watt, Telford, Stephenson, Rennie, Jessopp, Winsor, Cooke, Wheatstone, were none of them regularly brought up to the profession of engineering; yet they have done more to change its character, to advance its usefulness, than any men produced by polytechnic schools, schools of mines, or other organised methods of instruction. No man of genius was ever produced by the examination and diploma system. Many a man of genius is driven away from a pursuit in which he might otherwise have shone, by the restraints and difficulties such a system would throw in the way of his first steps. The Institution of the Ponts et Chaussées in France drove Brunel here. That somewhat solemn quack, Liebig, found it more easy to rise into European notice here than in his own country, notwithstanding his official position. Numerous instances may be cited of self-taught men who have started into notice—and done great good too, in their generation—in countries where art and science are free to all the world; but the exceptions of this kind in countries where diplomas exist are so few, that we may almost assert that they do not exist. The evils of restriction are, in our opinion, worse and greater than those of competition, for an ignorant pretender soon falls to his proper level. But who can appreciate the injury to society which may arise from the exclusion of any form of genius, educated or uneducated? To secure the introduction of the marvellous inventions we owe to our system of unrestricted freedom in engineering, such as the docks, railways; locomotives, steam-engines, steam-boats, gas-lighting, electric telegraphs, &c., &c., we would willingly run the risk of having homœopathic sewers laid down and taken up again. Our loss has been merely a money loss—one we can appreciate and repair. The loss which is occasioned by cramping the energies, and destroying the originality of a national mind, no human being can possibly divine.

Besides the fact that diplomas are useless to develope genius, our past experience shows that they are powerless to prevent many of the evils supposed to be inherent to freedom. Take, for instance, the medical profession within this century. Bleeding to excess was the fashion at one period; strong doses of mercury were the fashion at another; whilst now, there seems to be an equally dangerous tendency to leave nature to do its own work in disease. All the colleges and academies of the world, after trying experiments innumerable, and killing more patients than they have cured, have not been able to learn anything about the cholera, or to suggest any treatment which may not be found in Foderé's work, 'Recherches sur le Cholera Morbus,' 1831. St. John Long, Morrison, Hahnemann, and other quacks, had full play, notwithstanding our schools and diplomas; so that it appears the medical profession is no more protected from intruders, nor are its real merits enhanced, by the system which is supposed to secure both those results. Then, so far as engineering is concerned, the history of that science in France, Spain, and Belgium, proves that the professional organisation of those countries by no means protects them from the failures or accidents which happen here; whilst the ease with which the present French government has taken up the soft-water and pipe-sewer nonsense—exploded here—shows that the French are as open to receive quackery as any other nation. Diplomas, after all, can only be granted in consequence of the persons to whom they are given having passed a theoretical examination in the abstract principles of the pursuit they desire to enter. They prove nothing as to character, nor as to the power of dealing with new and unexpected difficulties. A man who has "crammed"—a mere pedant—will often pass an examination before which others, immeasureably his superiors in all real merit, would fail. But the real test of the value of this diploma system is in the practical results it has produced. How many double first-class men—how many senior wranglers—how many Eleves de l'Ecole Polytechnique, have in after life exhibited powers of a description to change the whole character of an age or country? How many, even, can decidedly be said to have been men of genius? We fear very few. There are amongst them, no doubt, men of great talent—men very remarkable amongst their contemporaries; but, of men of genius amongst them the number is but small.

To us, then, it seems evident that the diploma system would be very far from securing the results its advocates promise to themselves. Sincerely and earnestly do we urge the public to pause in the course it seems now disposed to rush blindly into, of trammeling, by such artificial arrangements, the exercise of intellect. Corporations have had their day,—why replace them by schools?

REVIEWS

Analytical View of Sir Isaac Newton's Principia. By Henry Lord Brougham, F.R.S., and E. J. Routh, B.A., Fellow of St. Peter's College, Cambridge. London: Longman. 1855. 8vo. pp. 442.

The value of the Principia as a subject of modern study depends on several other considerations besides its original intrinsic merit. The Principia is a cornucopia of inestimable gifts of knowledge, yet there are but few of the original discoveries contained in it which have not been in later times extended, and few of its demonstrations not simplified by modern analysis. No one contends that the whole of the masterpiece of Newton should be studied by the mathematical tyro; and the University course is usually confined to a comparatively small part of the work, relating to Newton's most important discoveries in astronomy, and the geometrical and mechanical propositions on which the demonstrations of those discoveries depend.

This selection of one of the subjects of the academical curriculum appears to have been made partly from respect for the name of Newton, partly from the importance of the subject historically considered, partly from a conviction that analytical reasoning, though more comprehensive and concise, is frequently less instructive than geometrical methods similar to those which Newton adopted. The reference to a diagram which a geometrical demonstration involves, frequently serves to give a quicker and more lively impression than the more abstract method of symbolical investigation.

Many parts of the Principia are, however, beset with difficulties which modern analysis in a great measure avoids. The extreme conciseness of the demonstrations, the omission of many steps in them, and the representation geometrically of quantities which are operated upon analytically, render many propositions of the Principia difficult to be understood. Accordingly, commentaries have been published having for their object the facilitating the study of the Principia; of these works the principal are Maclaurin's admirable general exposition of Newton, and the annotated edition of the Principia published by the Fathers Le Seur and Jacquier. These works were published in the middle of the last century, and there has long been room for a commentary which illustrated the Principia by the light of modern analysis.

This is the work which Lord Brougham and Mr. Routh have together undertaken. If they have not been perfectly successful in the accomplishment of their task, they have at least produced a work which a mathematical student may read with profit and instruction; and which those who are well versed in the subjects discussed may refer to with interest for the sake of the historical information. What principally strikes us as a general defect in this analytical view, is want of a well digested arrangement of the subjects, and exhaustive treatment of them. The work is too often desultory, and betrays that it is not the result of a single mind: it lacks that complete unity of purpose, that perfect harmony and necessary dependence of its parts which characterise the great work on which it is founded.

The object of the present treatise is said to be twofold. In the first place, it is designed for the benefit of "those who only desire to become acquainted with the discoveries of Newton and the his-

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tory of the science, but without examining the reasoning, and those who would follow the reasoning to a certain extent, and so far as a knowledge of the most elementary parts of geometrical and analytical science may enable them to go." (Introduction, p. xxi.) For the benefit of such readers, analytical demonstrations are given in the place of Newton's, where the analytical appeared simpler than the geometrical method. The other object of this treatise is stated to be "examining the connection of the different parts of the Principia with each other and with former and subsequent discoveries, showing its transcendant merits, and removing the objections, or rather the criticisms, that have sometimes been offered upon a few comparatively unimportant portions of the great work." (p. xxvii.)

In pursuance of these objects, the Three Books of the 'Principia' are examined, and illustrated by historical matter and references to subsequent investigations. In the discussion of the First Book, which relates principally to the Theory of Gravitation, and certain geometrical and mechanical propositions required for its exposition, the method of Fluxions is elucidated by reference to the Differential and the Integral Calculus, the investigations of Centripetal Forces by various writers are considered, the general results of the theories of central orbits and disturbed orbits are stated, and copiously illustrated by remarks on the labours of Euler, D'Alembert, Clairaut, Laplace, and Lagrange.

The analytical view of the Second Book of the Principia treats of the Elementary Principles of Hydrostatics, the Figure of the Earth, the Motion of a Particle in a Resisting Medium, the Motion of Fluids, and their Resistances. Newton's investigations respecting efflux of fluids, the motion of waves, the theory of sound, and the theory of tides, are also briefly stated. The work concludes with an Appendix of Notes, of which the longest relate to Central Forces and Leibnitz's Dynamical Tracts. There is also another series of Notes, of which one gives an account of some of Professor Stokes' investigations in Hydrodynamics, and another the modern theories respecting Tides. This seems a tolerably correct account of the contents of the work, but it is not easy to recapitulate them with complete accuracy, on account of the discursive and heterogeneous treatment adopted—one consequence of which is, that in the table of contents it has been deemed expedient to arrange the subjects in an order different from that of the pagination. Among other evidences of the want of a matured plan of the work is the circumstance that part of it, and only part, is divided into chapters. The analytical view contains, in the first place, 165 pages, which are not in any way divided in sections or chapters, and in which one and the same paragraph frequently treats of the subjects of different sections of the Principia; then follow about the same number of pages divided into chapters; then a hundred pages of "notes," numbered from 1 to 10 successively, and then another set of notes numbered from 1 to 5 successively. This confusion and patchwork are probably the result, in a great measure, of the double authorship of the work; but they sadly diminish its utility.

The faults, however, are not merely those of arrangement: there are several very serious errors in matters of principle. Our space will not permit us to more than briefly refer to the following. At page 90, it is said that "the inverse square of the distance, the actual law of gravitation is the only proportion which prevents the line of apsides from moving at all." This proposition is not correct, for where the central force varies directly as the distance, the orbit is an ellipse of which the apses do not progress.—The following extraordinary blunder occurs at page 169:

"The law expressing the equality of pressures in all directions is true in viscous as well as perfect fluids. The difference is this, that in the latter the transmission of the pressure is effected in a moment, in the former it takes place in *time*. During this interval the law is not true; but when a short time has been allowed to pass, the fluid takes up its form of equilibrium, and the pressure becomes equal in all directions."

Each sentence of this paragraph contains a distinct error. In the first place, the hydrostatic law of transmission of pressure is not true for viscous fluids. That the law is a consequence of the smoothness of the fluid particles, and of their not exerting mutual attractions, may be seen as follows. In a viscous fluid at rest, consider the equilibrium of a slender prism of the fluid of which the axis is horizontal. If a force be applied along the axis at one end of it, the equilibrium does not of necessity require that force to be balanced by an equal and opposite force at the other end of the prism; its equilibrium may be partly maintained by the horizontal frictions on its sides, or by the horizontal component of the forces of cohesion. Again, the second and third sentences of the paragraph just quoted, respectively omit the consideration of the effects of the inertiæ of perfectly smooth and viscous fluids. Also, the third sentence speaks of "the form of equilibrium" of a viscous fluid as *one*, whereas it has infinite diversities within certain limits.

Such defects are serious, considering especially the nature of the work, and the class of readers for whom it is intended. But these objections are not inconsistent with a full appreciation of the research which many parts of the work display. It is neither very original, nor very exact, nor well arranged; but it is generally perspicuous, and contains a considerable quantity of interesting and valuable information, which the historical and literary attainments of one of its authors, and the mathematical studies of the other, well qualified them to collect.

GAS COMPANIES AND THE ENGINEERING PROFESSION.

In common with all whose inclinations or pursuits lead them to peruse the publications devoted to mechanical science or any of its branches, we have had our attention attracted by a series of letters which have appeared in the *Gas and Water Times*, almost regularly since the month of May, on the state of the London Gas-works, many of the statements in which, the author (who evidently understands his subject) says, are applicable to the majority of similar establishments; and as the truth of some of his assertions has already been testified by those whose deepest interest it would have been to contradict them if possible, and as not one of them has been disproven, we are bound to receive them as correct.

The unenviable notoriety which some of the gas companies have acquired by the extraordinary revelations which have, from time to time, been made, calls loudly for some reform in their management; and although in some cases the faults have appeared to lie rather with the financial than the manufacturing department, yet, in others, the want of engineering skill and integrity has been so flagrantly glaring, that we have often wondered at the shareholders being so blind to their own interests as to permit retention of office by men who have so shamelessly abused the trust reposed in them. Had the injustice thus committed been confined to themselves, these cases would have been sufficiently reprehensible, as in all companies there are shares held by men who live at too great distances, or who are too much occupied with their daily avocations to be able personally to attend even the half-yearly meetings, and who are consequently obliged to leave the guardianship of their interests to those who can and do attend, and to whom they naturally suppose the proper management of the respective concerns to be of as much importance as to themselves, a course to which the widows and orphans of departed shareholders, who looked to these properties as some provision for their families, are unavoidably reduced; but, unfortunately, the evil does not end even here, as it ramifies through the community in various ways. With these it is not our purpose at present to interfere, further than the class to which this *Journal* is devoted is thus affected.

The public seldom understands, and still more rarely reasons on the wideness of the field in which the operations of mechanical science are performed, and the consequent variety of the subordinate departments, the whole, or nearly the whole, of which come, more or less, under the control of the "civil engineer." Hence, not only are impostors able frequently to assume the title with impunity, and even temporary advantage, but classes of men who have not a shadow of a claim to the honour, get confounded with the profession. Were this not so— that is, were the public sufficiently alive to their own interests, to take care that none but thoroughly qualified men were intrusted to conduct mechanical operations—we should not see so many losses sustained by those pecuniarily involved, on the one hand, nor so much disappointment and dissatisfaction in those supplied, on the other. Thus, a very small per centage of the managers of gas works belong to the engineering profession, and, therefore, we see that a very large proportion of these establishments are a disgrace to the intelligence of the age. An able letter on this subject has been addressed to Mr. Hawkins, the Chairman of the London Gas Company by Mr. F. W. Beaumont, civil engineer, who has

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since published it. This gentleman, as it now appears, is the author of the series to which we allude in the commencement of this article, and the early part of which appeared under the signature of "One who has studied the interests of the (London) Company."

We may probably have to return to this subject hereafter; in the mean time, we cannot help saying that the engineering profession, the public, and the shareholders in gas companies, are deeply indebted to Mr. Beaumont for grappling with a monster evil.

REGISTER OF NEW PATENTS.

PERMANENT WAY OF RAILWAYS.

JOSEPH ARMSTRONG, of the Normanton Station, Wakefield, and JOHN LIVINGSTON, of Leeds, *Inventors.*

[This invention received Provisional Protection, but notice to proceed was not given within the time prescribed by the Act.]

These improvements are designed for the purpose of dispensing with the use of "switches" or "points" as heretofore constructed and employed on railways for passing a train of carriages from one line of rails to another. The mode heretofore commonly practised of constructing such parts has been to plane them to a taper point, and the object of these improvements is to obviate the necessity for pointing such parts by substituting in lieu thereof the following arrangement.

At those parts of a line of railway where a crossing occurs, the inventors place a pair of sliding rails, formed either single or double headed, and they connect each such pair of rails securely together in any convenient manner at such distances asunder that the flanges of the wheels of the carriages may pass clear between them; and that one end of such sliding rails corresponds with the butt ends of the crossing and main rails of the permanent way, and the other end of the butt ends of one of the rails of each such pair corresponds with the butt ends of the rails of the main line only; and it is at this particular juncture that the action of the slidiug rails takes place, so as to present one or other of the ends thereof opposite to those of the main rails, whilst the opposite ends of the sliding rails are securely connected by "fishing" or otherwise to the fixed rails which form the crossing and the main line. An important feature in these improvements consists in rendering the aforesaid sliding rails self-acting, which the inventors effect by the use and employment of two check rails or bars securely fixed to the sleepers of the permanent way between the inner pair of the aforesaid sliding rails. The ends of these check rails or bars are curved inwards, and are so fixed with respect to the main rails as that the straight part of such check rails allow the flanges of the wheels of the carriages to pass between them and the side of one or other of the sliding rails, according to the position such rails occupy with respect to the fixed rails. The effect of thus arranging and combining the before-mentioned sliding rails and fixed check rails with the ordinary crossing rails and those of the main line will be better understood by the following example of the mode of operating therewith:—Supposing the aforesaid sliding rails to be pulled or pushed by means of a handle so as to connect the crossing rails with the rails of the main line, a portion of one of the inner rails of one pair of sliding rails will be pulled under that particular fixed check rail which is nearest thereto; and in like manner and simultaneously with such movement the inner rail of the other pair of sliding rails will be pulled from under the other fixed check rail, and in this manner and by these means railway carriages may be passed, or their course diverted from one line of rails to another; the curved ends of the aforesaid fixed check rails serve to ensure such diversion from the main line by the flanges of the wheels coming into contact with curved ends of the aforesaid check rails, thereby forcing and retaining the wheels of the carriages in their proper course. But supposing the carriages to be passing from a crossing or siding to the main line in an opposite direction to that above mentioned, the flanges of the wheels coming into contact with that portion of the sliding rail which is under one or other of the fixed check rails will force the sliding rail outwards, and thus bring the ends of the crossing rails opposite to those of the main line. A weight attached to the handle which actuates the sliding rails, throws the crossing rails out of a line with those of the main line after the flanges of the wheels have passed the check rails, and thus renders the aforesaid sliding rails self-acting.

ORNAMENTING GLASS.

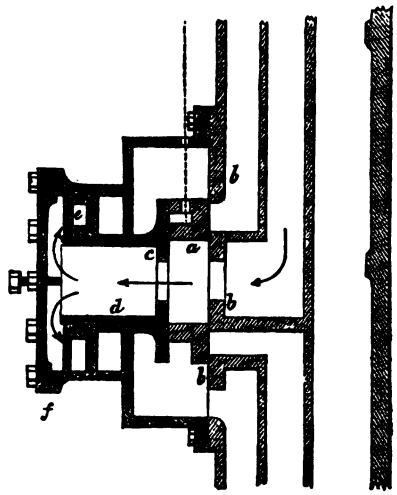
G. F. WILSON and G. PAYNE, Belmont, Vauxhall, *Patentees,* April 11, 1855.

This invention consists of crystallizing fatty acids on the surface of glass or between two surfaces of glass. The patentees describe it as follows:—We find that the best result is obtained by previously warming the glass vessel to be coated beyond the melting point of the fat acid used, in a steam closet or oven, or in any convenient way. The glass vessel should then be filled with the fat acid, removed from the hot closet or oven, and allowed to cool gradually until crystals appear forming on the inner surface of the glass. The glass vessel should then be cooled rapidly by dipping in cold water, and the excess of fat acid emptied out. Different appearances may be obtained from the same fat acid by varying the time of cooling.

SLIDE-VALVES OF STEAM-ENGINES.

ISAIAH VERNON, West Bromwich, *Patentee,* April 12, 1855.

The invention consists of a method of constructing the slide-valves of steam-engines, whereby the pressure of the said valves on their beds or seats may be wholly removed, or diminished to any desired degree.



Our engraving represents a vertical section of portion of a steam-engine cylinder, with a slide-valve constructed according to the invention. *a*, is the slide-valve; and *b*, *b*, *b*, the seat or bed against which the said valve slides. Instead of making a fixed back to the valve *a*, a detached back *c*, is substituted, which bears against the valve *a*, pressing it to its bed *b*, *b*, *b*. The back *c*, does not move with the valve *a*, but the valve *a*, moves between the seat *b*, *b*, *b*, and the back *c*, as between two fixed surfaces. A pipe *d*, is connected to the back of the plate or back *c*, which pipe is furnished at its end with a flange *e*, which flange constitutes a piston working steam-tight in the cylinder *f*. The course of the steam is indicated by arrows, by which it will be seen that the steam passes through the valve *a*, back *c*, and pipe *d*, into the cylinder *f*, where it presses upon the piston *e*. The pressure on the piston *e*, is transmitted through the pipe *d*, to the back or plate *c*, and the back of the valve *c*, pressing upon the valve *a*, keeps the valve *a*, to its bearing on the seat or bed *b*, *b*, *b*. By making the area of the piston *e*, larger or smaller, a greater or less amount of pressure may be transmitted to the plate *c*, and made to press the valve *a*, to its bed or seat *v*, *v*, *v*. The induction and eduction pipes do not differ in any essential respects from those ordinarily employed.

Claim.—The method described of constructing the slide-valves of steam-engines, that is to say by causing the said valves to work between the bed or seat and a plate or detached back, the said plate or back pressing the said valve to its bed or seat, the pressure being produced by the action of the steam upon a piston connected with the said plate or back.

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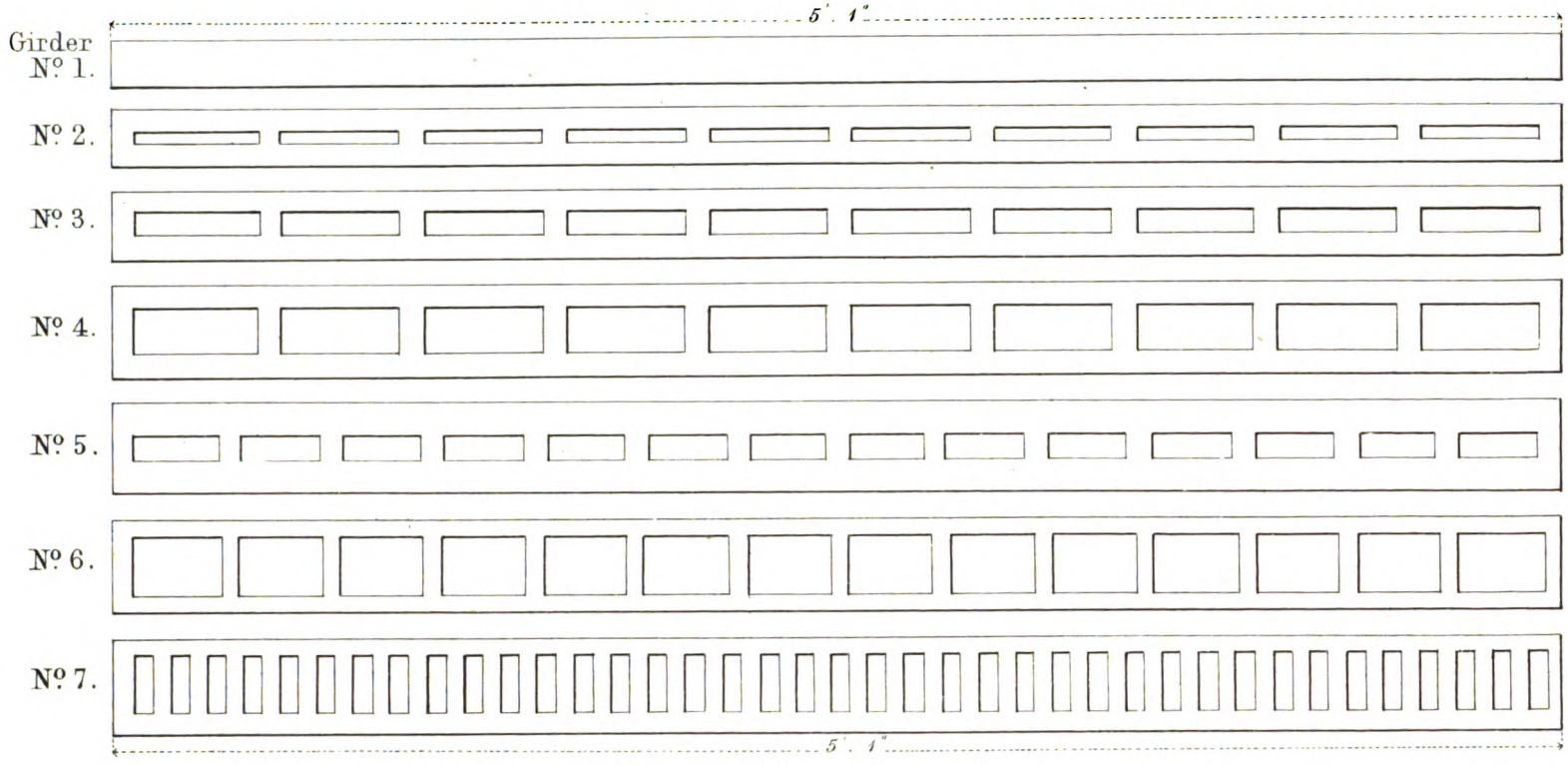
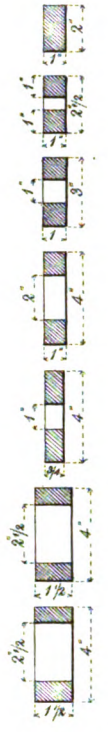
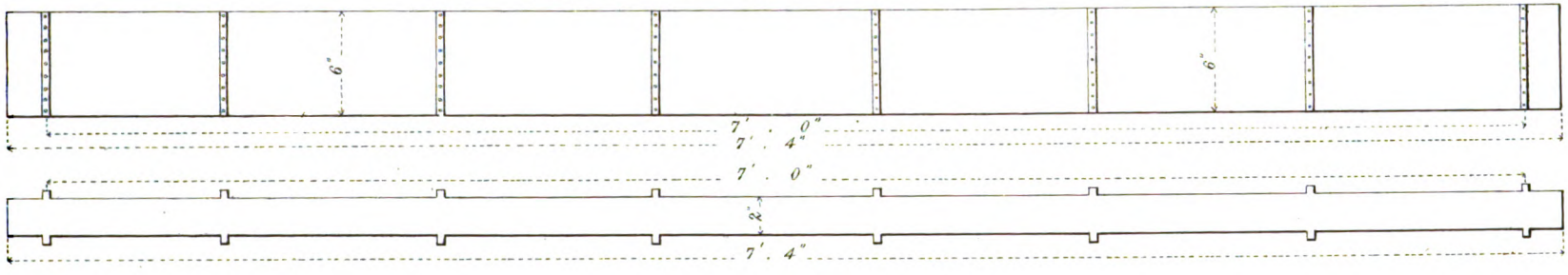
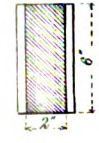




Beam employed in determining the position of the neutral axis.





Measuring Instrument.
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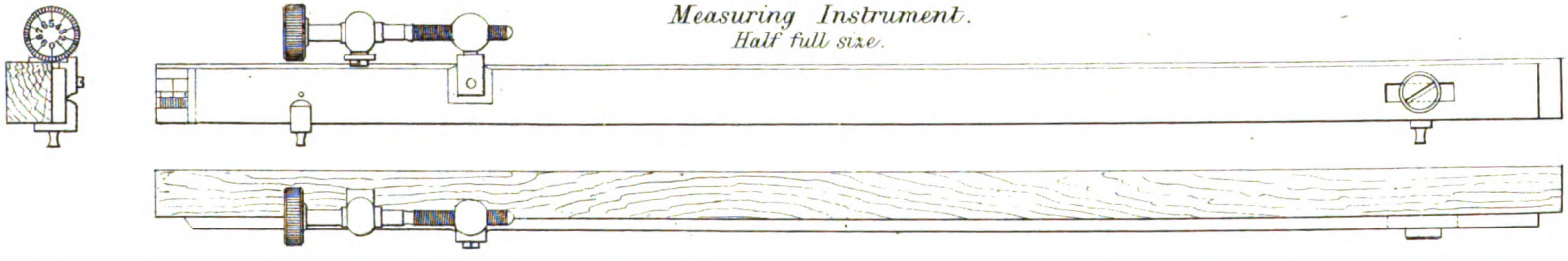

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CITY BATHS AND WASH-HOUSES.

The subject of public baths and washhouses for the City of London is at the present time engaging the attention of a sub-committee of the corporation specially nominated to consider not only the petition of the guardians of the West London Union, recently presented, but also the general question—the admitted great social want of such institutions within the city. Nothing at present, as far as we are informed, has been definitely determined; but we believe we may state, that in all probability the report of the committee will include a recommendation to the Court of Common Council to appropriate the western portion of Farringdon Market for such an establishment. It is notorious that the ill-fated building, as a market, yields but a very nominal rental indeed to the corporation; the loss, therefore, that would have to be sustained in the transfer is unworthy of consideration. Some may possibly suggest that a better site could have been selected in the immediate neighbourhood: nevertheless, when it is borne in mind that the proposed portion of the present market building might be adapted, at a comparative small cost, for the purpose of baths and washhouses, to that which must inevitably be expended in erecting an entire new structure for the purpose elsewhere—and moreover, that what is now literally not only useless but profitless, would then be turned to so highly beneficial and laudable an account—few, if any, it is hoped, will be found to take exception to such a recommendation.

THE RESISTANCE OF FLEXURE.

On the existence of an element of Strength in Beams subjected to Transverse Strain, arising from the Lateral Action of the fibres or particles on each other.

By William Henry Barlow, F.R.S.

(*With an Engraving, Plate* II.)

It has long been known, that under the existing theory of beams, which recognises only two elements of strength, namely, the resistances to direct compression and extension, the strength of a bar of cast-iron subjected to transverse strain cannot be reconciled with the results obtained from experiments on direct tension, if the neutral axis is in the centre of the bar.

The experiments made both on the transverse and on the direct tensile strength of this material have been so numerous and so carefully conducted, as to admit of no doubt of their accuracy; and it results from them, either that the neutral axis must be at, or above, the top of the beam, or there must be some other cause for the strength exhibited by the beam when subjected to transverse strain.

In entering upon this question, it became necessary to establish clearly the position of the neutral axis, and the following experiments were commenced with that object; but they have led to others which are also described herein, and which establish the existence of a third, and a very important element of strength in beams.

I was desirous that the experiments for determining the position of the neutral axis should be made on such a scale and in such a manner as to place this question beyond doubt; and with this object the following means were adopted:—

Two beams were cast, 7 feet long, 6 inches deep, and 2 inches in thickness; on each of which were cast small vertical ribs at intervals of 12 inches: these ribs were one-fourth of an inch wide, and projected one-fourth of an inch from the beam. In each rib nine small holes were drilled to the depth of the surface of the beam, for the purpose of inserting pins attached to a delicate measuring instrument; the intention being to ascertain the position of the neutral axis by measuring the distance of the holes in the vertical ribs when the beam was placed under different strains. The measuring instrument consisted of a bar of box-wood, in which was firmly inserted, at one end, a piece of brass, carrying a steel pin; and at the other end a similar piece of brass carrying the socket of an adjusting screw. The adjusting screw moved a brass slide, in the manner shown in Plate II, which carried another pin similar to that inserted in the box-wood bar, at the other end of the instrument. The instrument was first made entirely of brass; but the effects of expansion from the heat of the hand were so sensible, that the wooden bar was substituted. The pins on the instrument fitted loosely into holes in the beam; and the mode of using the instrument was, to bring the pins up by means of the screw against the side of the holes with a certain degree of pressure, which, with a little practice in using the instrument, was attained with considerable accuracy.

Two beams were employed in order to avoid errors which might arise from accidental irregularities in the metal. The head of the adjusting screw was graduated to 100 divisions, and the screw had 43·9 threads to the inch, so that one division was equal to $\frac{1}{4390}$ of an inch.

The measurements were, in all cases, taken by the outsides of the pins of the measuring instrument; and when the instrument read zero, the actual distance of the outer sides of the two pins was $\frac{51661}{4390}$ inches, so that the constant number 51661 being added to the micrometer readings gives, in each case, the total distance in terms of $\frac{1}{4390}$ of an inch. The form and dimensions of these beams are given in Plate II.

The measurements were taken four times in each position of the beam, and the error of measurement did not generally exceed from one to two divisions; but if in the four observations an error amounting to more than four was found, it was corrected by remeasurement.

The numbers given in the following tables are the micrometer readings, and the *means* of four observations in each case. In these experiments more than 3000 measurements were taken; but to avoid unnecessary figures, only the more prominent results are given.

Table No. I. contains the measurements of the centre division of the first beam under eight different conditions.

Table No. II. contains similar measurements of the second beam.

In the first experiment it was found that, when the beam was inverted, the measuring instrument appeared to bear upon a different part of the holes, so that a direct comparison between the distances, in the beam erect and inverted, cannot be made with the same accuracy as the comparisons of different strains upon the beam when in the same position. The first beam had been subjected to strain for the purpose of testing the measuring instrument previous to these experiments being made; but the second beam had not; and it will be seen that the effect of the strains in the latter case caused a permanent lengthening of the beam. The same strain was frequently applied afterwards, but I could not observe any increase of this effect. There was certainly a further apparent lengthening of both beams; but I ascertained that this arose from a slight wearing of the working parts of the measuring instrument, from the great number of measurements taken. In both experiments the beam was measured, first, in an erect position; and secondly, inverted; but in the tables, the measurements of the same parts of the beam are placed opposite each other, so that they may be compared throughout with greater facility.

Considering the very minute quantities which had to be measured, and the numerous causes of disturbance to which observations of so much delicacy were liable, such as changes of temperature or want of perfect uniformity in the dimensions or texture of the beams, the results, as shown by the column of differences, exhibit more regularity than could have been expected; and they point out the position of the neutral axis, as the centre of the beam, in a manner so decided, as to remove all further doubt upon this subject, not only in the smaller strains, but in the larger ones also; which, in the case of the second beam, were carried to about three-fourths of the breaking weight.

It will be observed also that the extensions and compressions increase in an arithmetical ratio from the centre to the extreme upper and lower sides of the beam.

These experiments having established the fact that the neutral axis is in the centre of a rectangular beam, and that its position is not sensibly altered by variations in the amount of strain applied, it becomes evident that if there were no other elements of strength than the resistances to direct extension and compression, the well-known formula

$$W = \frac{2adf}{3l}$$

should give the breaking weight when f is equal to the smaller of these two resistances, which in cast-iron is the tensile resistance. But the weight so calculated is less than half the actual strength of the beam.

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TABLE I.—*Measurements of the First Beam.*

Beam erect.					Beam inverted.							
No. 1.		No. 2.		No. 3.	No. 4.		No. 5.		No. 6.		No. 7.		No. 8.
At rest previous to being strained.	Difference.	Strained with 7373 lbs. on the end, equal to 14,746 lbs. on the centre.	Difference.	Weight taken off, condition the same as No. 1.	Beam reversed bearing its own weight on the centre.	Difference.	Strain of 2893 lbs. on the end, equal to 5786 lbs. on the centre.	Difference.	Strain of 5133 lbs. on the end, equal to 10,066 lbs. on the centre.	Difference.	Strain of 7373 lbs. on the end, equal to 14,706 lbs. on the centre.	Difference.	Weight taken off, condition the same as No. 4.
Micrometer readings.		Micrometer readings.		Micrometer readings.	Micrometer readings.		Micrometer readings.		Micrometer readings.		Micrometer readings.		Micrometer readings.
2208	+ 70	2278	— 67	2211	2210	— 33	2177	— 25	2152	— 26	2126	+ 71	2197
2186	+ 55	2241	— 53	2188	2187	— 25	2162	— 16	2146	— 21	2125	+ 53	2178
2095	+ 36	2131	— 33	2098	2103	— 20	2083	— 12	2071	— 13	2058	+ 36	2094
2127	+ 14	2141	— 13	2128	2129	— 10	2119	— 8	2111	— 5	2106	+ 21	2127
2110	— 5	2105	+ 5	2110	2117	— 2	2115	— 1	2114	+ 2	2116	—	2116
2052	— 21	2031	+ 13	2054	2060	+ 5	2065	+ 6	2071	+ 12	2083	— 20	2063
2095	— 39	2056	+ 42	2098	2101	+ 15	2116	+ 14	2130	+ 19	2149	— 37	2112
2052	— 58	1994	+ 68	2052	2056	+ 21	2077	+ 21	2098	+ 29	2127	— 60	2067
2101	— 73	2028	+ 76	2104	2111	+ 28	2139	+ 26	2165	+ 34	2199	— 73	2126

TABLE II.—*Measurements of the Second Beam.*

Beam erect.							Beam inverted.				
No. 1.		No. 2.		No. 3.		No. 4.		No. 5.		No. 6.		No. 7.
At rest previous to being strained.	Difference.	Strain of 8000 lbs. on centre.	Difference.	Strain of 16,000 lbs. on centre.	Difference.	Weight removed.	Difference.	Strain of 8000 lbs. on centre.	Difference.	Strain of 16,000 lbs. on centre.	Difference.	Weight removed.
Micrometer readings.		Micrometer readings.		Micrometer readings.		Micrometer readings.		Micrometer readings.		Micrometer readings.		Micrometer readings.
1633	+37	1670	+65	1735	—89	1646	—44	1602	—56	1546	+97	1633
1525	+28	1553	+47	1600	—63	1537	—24	1513	—46	1467	+67	1534
1481	+21	1502	+34	1536	—44	1492	—19	1473	—28	1445	+42	1487
1442	+11	1453	+21	1474	—23	1451	—10	1441	—12	1429	+22	1451
1392	+ 2	1394	+ 7	1401	— 1	1400	+ 1	1401	—	1401	+ 4	1405
1375	—10	1365	— 9	1356	+18	1374	+17	1391	+11	1402	—17	1385
1338	—18	1320	—24	1296	+44	1340	+20	1360	+27	1387	—35	1352
1257	—27	1230	—37	1193	+64	1257	+31	1288	+43	1331	—57	1274
1248	—42	1206	—46	1160	+85	1245	+44	1289	+57	1346	—78	1268

Note.—The extensions are marked +; the compressions are marked —.

In considering this question, I was forcibly struck by the circumstance, that, in applying the law of *ut tensio sic vis* to contiguous fibres, under different degrees of tension and compression, the effect of lateral adhesion is omitted, and each fibre is supposed to be capable of taking up the same degree of extension and compression from the same force as if it acted separately, and independently of the adjoining fibres. But it is well known as a practical fact, that there is a powerful lateral action which tends to modify the effect of unequal strains.

If, for example, a bar *a b c d*, have a strain applied at *e f d b*, the portion *d e f b* will not be extended so much as it would be if separated from *a c e f*, unless an equal strain is applied to the portion *a c e f*. And if a portion of a bar cannot be extended in proportion to the force applied to it, unless the contiguous part is equally strained, it follows that the outer portions of a beam subjected to transverse strain will not be extended in proportion to the force applied, because the part nearer the neutral axis is not equally strained. The measurements made for obtaining the position of the neutral axis afford direct evidence on this point.

In the first beam, a strain of 5786 lb. caused an extension of twenty-eight divisions of the micrometer; the points measured

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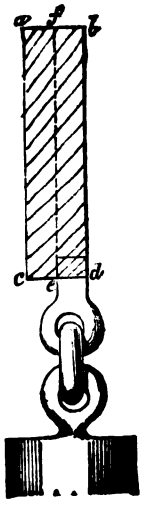
were $\frac{1}{12}$ths of the depth of the beam. The extension at the outer fibres was therefore $28 \times \frac{1}{12} = 30$ divisions. The micrometer reading before the strain was applied was 2111, and the total distance of the points measured was $2111 + 51661 = 53772$. The effect of the strain caused therefore an extension of $\frac{30}{53772} = \frac{1}{1792 \cdot 4}$ of the length. The beam was 7 ft. 4 in. long, 6 inches deep, and 2 inches thick; and as



$$W = \frac{2adf}{3l}$$

$$f = \frac{3lW}{2ad}$$

$$\text{or } f = \frac{3 \times 88 \times 5786}{2 \times 12 \times 6} = 10{,}608 \text{ lb.};$$

so that, with a strain of 10,608 lb. at the outer fibres, the extension produced was $\frac{1}{1792 \cdot 4}$ of the length.

But in referring to the experiments made by Mr. Hodgkinson, it will be seen that a force of 10,538, applied by direct tensile strain, extends cast-iron $\frac{1}{1056}$th of its length, being nearly double that exhibited by the beam.

In the second beam, a weight of 8000 lb. (from the mean of two results) produced an extension of forty divisions, which at the extreme fibres will be $40\frac{1}{12} = 44$ divisions.

The mean reading of the micrometer, previous to the strain being applied, was 1439; therefore the extension was

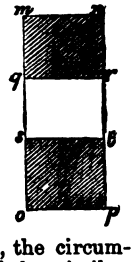
$$\frac{44}{51661 + 1439} = \frac{1}{1207}.$$

The strain at the outer fibres produced by this weight was 14,666 lb.; so that 14,666 lb. to the inch caused an extension of $\frac{1}{1207}$th of the length.

But referring again to Hodgkinson's experiments on direct tensile strain, a weight of 14,793 lb. produced an extension of $\frac{1}{845}$th of the length; which is again nearly double that produced by the same strain when excited by a weight applied transversely.

From these and other considerations I was led to think it probable that the effect of the lateral action of the fibres or particles of a beam, tending to modify the effect of the unequal strains and opposite forces, and thus diminishing the amount of extension and compression which would otherwise arise, constituted in effect a *resistance to flexure*; and it will be found that the following experiments fully confirm the existence of this resistance as an additional element of strength in beams; and that it explains the apparent anomaly in the amount of tensile resistance when excited by direct and by transverse strains.

Assuming the probability of a resistance, acting independently of, or in addition to, the resistance of direct tension and compression, and varying with the flexure, it occurred to me that it might be exhibited experimentally by casting open girders of the forms shown figs. 2, 3 and 4, having the same sectional area in the upper and lower ribs; the same number of vertical ribs, but the distance between the horizontal ribs, and consequently the deflections of the girders, different.



In these girders the neutral axis would necessarily be (like that of the solid beam) in the centre, and the sectional area of the ribs subjected to tension and compression being the same in each, the circumstances under which rupture would ensue would be similar, except in the amount of flexure.

The formula for the strength of a girder of this form is as follows:—

Let a = the united area contained in the upper and lower ribs;

a' = the intervening space;

d = the total depth;

c = the distance between the upper and lower ribs;

l = the length of bearing;

W = the breaking weight;

and F = the force required to produce rupture in the extreme fibres or particles.

Then $a + a'$ = the total area of the rectangle m, n, o, p,

$$W = \frac{2dF}{3l}(a' + a) - \frac{2oa'}{3l} \times \frac{cF}{d};$$

or

$$W = \frac{2F}{3l}\left\{(a' + a)d - \frac{a'c^2}{d}\right\},$$

$$W = \frac{2Fa}{3l}\left(d + c + \frac{c^2}{d}\right).$$

The formula may also be obtained by calculating the moments in the usual way. Using the same letters as before, we have, for the distance of the centres of compression and extension,

$$\frac{2}{3}\left(d + \frac{c^2}{d + c}\right).$$

The force acting when F is the strain which breaks the outer fibre, will be

$$\frac{F + \frac{Fc}{d}}{2} = F\frac{\left(1 + \frac{c}{d}\right)}{2}.$$

Hence

$$\frac{W}{2} \times \frac{l}{2} = \frac{2}{3}\left(d + \frac{c^2}{d + c}\right)\left(\frac{1 + \frac{c}{d}}{2}\right)\frac{aF}{2};$$

or

$$W = \frac{2Fa}{3l}\left(d + c + \frac{c^2}{d}\right).$$

The value of W being obtained by experiment in each case, we have from the formula

$$F = \frac{3lW}{2a\left(d + c + \frac{c^2}{d}\right)}$$

and if the strength depended only on the direct tensile power of the material, F should in each case be constant, and equal to the direct tensile resistance; but if, in addition to this, there existed another element of strength in the resistance occasioned by the lateral adhesion and varying with the flexure, the value of F would be found, in every case, greater than the tensile resistance, and to increase when the flexure increased.

Four beams were cast of each form, of which the details, the exact dimensions, deflections, and breaking weights are given in the Appendix. The results were as follows, obtained from the mean of four experiments on each form of girder:—

Description of beam.	Total depth of beam. inches.	Sectional area of the two ribs. inches.	Distance between the ribs. inches.	Deflection with nine-tenths of breaking weight. inches.	Breaking weight. lb.
Form No. 2...	2·51	1·98	·54	·510	2468
Form No. 3...	3·00	2·20	1·00	·401	3119
Form No. 4...	4·00	1·98	2·03	·301	4339

The value of F being derived from each of these results by the formula

$$F = \frac{3lW}{2a\left(d + c + \frac{c^2}{d}\right)}.$$

	Deflection.	Value of F.
Form No. 2	·510	35386
Form No. 3	·401	31977
Form No. 4	·301	28032

The tensile strength of the metal obtained from the mean of eight experiments, given in the Appendix, was 18,760 lb.; here, therefore, was decided evidence, first, that the value of F exceeded the tensile strength in all three forms, and that it increased with the increase of flexure.

In connection with the above-described experiments, I made four others on solid beams having the same sectional area and length as the open girders; and the mean of the four gave a breaking weight of 1888 lb. Obtaining the value of F from these experiments, we have,—

Deflection with nine-tenths of breaking weight.	Value of F.
·670	41709 lb.

which again exhibits an increase in the value of F, with an increase in the deflection.

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The foregoing experiments having shown that in girders containing the same depth of metal, the resistance arising from the lateral action of the particles depended on the amount of the flexure, I thought it desirable to make other experiments to ascertain how this resistance varied in girders having the same total depth, and consequently nearly the same deflection, but with different depths of metal in the girder. For this purpose beams were cast of the forms Nos. 5, 6 and 7, each 4 inches deep, and with the upper and lower ribs, $1\frac{1}{2}$ inch by $\frac{3}{4}$-inch, the ribs being placed as shown in the figures, so that the depth of the metal in No. 5 was twice as great as in Nos. 6 and 7.

Four beams were cast of each form,—the exact dimensions and breaking weights are given in the Appendix,—and the mean results were as follows:—

Description of beam.	Depth of beam.	Depth of metal.	Sectional area.	Deflection.	Breaking weight.
Form No. 5...	4·04	3·01	2·320	·322	5141
Form No. 6...	4·04	1·48	2·230	·310	5147
Form No. 7...	4·07	1·56	2·380	·262	6000

Obtaining the value of F from these experiments, and comparing them with beam No. 4, which had the same total depth, we have—

	Deflection.	Depth of metal.	Value of F.
Form No. 5	·322	3·01	37408
Form No. 4	·301	1·97	28032
Form No. 7	·262	1·56	27908
Form No. 6	·310	1·48	25271

The experiments did not afford so complete a comparison as the former series, because the intervals between the vertical ribs were not equal, nor in the same proportion to the depth of metal, the effect of which would be to vary to some extent the form of the curve of deflection. Nevertheless, they show in an equally decided manner, that when the deflection is the same the resistance increases when the depth of metal in the beam is increased.

The foregoing experiments have therefore elicited three facts as regards beams formed of two parallel bars separated at given intervals by vertical ribs:—

First, that in every case the resistance, or the value of F, is greater than that due to the tensile resistance of the metal.

Secondly, that with the same depth of metal in the beam, and the same distance of bearing, the resistance is greater when the deflection is greater.

Thirdly, that with the same deflection and the same length of bearing, the resistance is greater when the depth of metal in the beam is greater.

And it follows from these results, that there is an element of strength depending on the amount of deflection in connection with the depth of metal in the beam, or in other words, dependent upon the degree of flexure to which the metal forming the beam is subjected.

The existence of an element of strength in addition to the resistances to direct tension and compression being clearly proved by these experiments, it becomes interesting to ascertain the law under which it varies, in the form of beams experimented upon.

Now, if from the value of F, the tensile strength of the metal is deducted, it will be found that the remainder maintains nearly a constant ratio in each case to the depth of the metal in the beam multiplied by its deflection. It would appear, therefore, that the total resistance, or the value of F, is composed of two quantities; one being constant and limited by the resistance to direct tension, and the other varying directly as the degree of flexure to which the metal forming the beam is subjected.

The applicability of this simple law may be tested by the results of the experiments, as follows:—

Let φ = the resistance to flexure in the solid beam at the time of rupture;

and let D = the depth,

δ = the deflection,

f = tensile resistance,

and F = total resistance.

Then in the solid beam

$$f + \varphi = F;$$

and let F′, D′ and δ', represent the total resistance, depth of metal, and deflection of any other of the beams; then, the lengths being equal, if the resistance arising from the lateral action varies as the depth of metal into the deflection,

$$F' = f + \varphi \frac{D'\delta'}{D\delta}.$$

The value of φ may be determined from this equation, applied to each of the experiments, in two ways; first, by supposing f to be a constant quantity; and secondly by supposing f and φ to have a constant ratio.

By the first mode, the whole of the errors of observation and irregularities of the strength of the metal would be accumulated in φ. By the second method, these irregularities will be divided between the values of f and φ.

Adopting therefore the second method, let 1 to m represent the ratio of f to φ: then

$$f = m\varphi,$$

and

$$m\varphi + \varphi \frac{D'\delta'}{D\delta} = F';$$

or

$$\varphi = \frac{F'}{m + \frac{D'\delta'}{D\delta}},$$

which ought to be a constant quantity in all the experiments.

We cannot obtain the deflections at the line of rupture, but they may be assumed to be proportional to the deflections with $\frac{9}{10}$ths of the breaking weights in each case.

Now the value of F in the solid beam was found to be 41,709 lb.; and the value of f, from the experiments on direct tension, was 18,750 lb.: and as in the solid beam

$$f + \varphi = F,$$

φ will be 22,959 lb.,

and the ratio of φ to f will be as 1 to ·81.

For the purpose of comparison, I have deduced the value of f and φ, in solid beams, from the experiments of Mr. Hodgkinson on ten different descriptions of metal; the results of which are given in the following table (See p. 13):—

The mean ratio of φ to f in these metals appears to be as 1 to ·78. The metal used in my experiments was a mixture consisting of two-thirds of South Staffordshire No. 3, hot blast pig, and one-third old metal recast. As compared with Mr. Hodgkinson's experiments, its strength accorded nearly with that of the Carron iron No. 3, hot blast.

The mean ratio of φ to f, obtained from Mr. Hodgkinson's experiments, being as 1 to ·78, and from the experiments herein detailed being as 1 to ·81, we may consider f to be four-fifths of φ; and therefore

$$m = ·8.$$

Using this ratio, the values of φ and f, derived from the formula

$$\varphi = \frac{F}{m + \frac{D'\delta'}{D\delta}}$$

and

$$f = \varphi m,$$

as applied to each of the experiments, are given below:—

No. 1. $\varphi = \dfrac{41709}{·8 + \frac{2·012 \times ·670}{2·012 \times ·670}} = 23{,}171$ lb., $f = 18{,}537$ lb.

No. 2. $\varphi = \dfrac{35386}{·8 + \frac{1·97 \times ·510}{1·348}} = 22{,}904$ lb., $f = 18{,}323$ lb.

No. 3. $\varphi = \dfrac{31977}{·8 + \frac{2·01 \times ·401}{1·348}} = 22{,}890$ lb., $f = 18{,}312$ lb.

No. 4. $\varphi = \dfrac{28032}{8· + \frac{1·97 \times ·301}{1·348}} = 22{,}606$ lb., $f = 18{,}085$ lb.

No. 5. $\varphi = \dfrac{37408}{·8 + \frac{3·01 \times ·322}{1·348}} = 24{,}626$ lb., $f = 19{,}501$ lb.

No. 6. $\varphi = \dfrac{25270}{·8 + \frac{1·48 \times ·310}{1·348}} = 22{,}167$ lb., $f = 17{,}734$ lb.

No. 7. $\varphi = \dfrac{27908}{·8 + \frac{1·56 \times ·262}{1·348}} = 25{,}302$ lb., $f = 20{,}242$ lb.

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Description of iron.	Transverse strength of bar 1 inch square and 54 inches between the supports.	Tensile strength per square inch.	Value of $f + \phi$ from the formula $w = \frac{2ad\,(f+\phi)}{8l}$.	Value of ϕ from the formula $w = \frac{2ad\,(f+\phi)}{8l}$, $\phi = \frac{8lw}{2ad} - f$.
	lb.	lb.	lb.	lb.
Carron iron No. 2, cold blast	476	16,683	38,556	21,873
Carron iron No. 2, hot blast	463	13,505	37,503	23,998
Carron iron No. 3, cold blast	446	14,200	36,126	21,926
Carron iron No. 3, hot blast	527	17,755	42,687	24,932
Devon iron No. 3, hot blast	537	21,907	43,497	21,590
Buffery iron No. 1, cold blast	463	17,466	37,503	20,037
Buffery iron No. 1, hot blast	436	13,434	35,316	21,882
Coed-Talon iron No. 2, cold blast	413	18,855	33,453	14,598
Coed-Talon iron No. 2, hot blast	416	16,676	33,696	17,020
Low Moor iron No. 3, cold blast	467	14,535	37,827	23,292
Means	464	16,502	37,616	21,114

These results, though not exhibiting complete regularity, are sufficiently uniform to indicate that the assumed law of the variation of this resistance is a close approximation to the truth. It will be observed also, that Nos. 2, 3, 4 and 6, give a smaller value of ϕ than Nos. 1, 5, and 7, which probably arises from the difference in the proportion which the distance between the vertical ribs bears to the depth of the metal, a circumstance which would affect, to some extent, the form of the curve of deflection.

In the formula

$$\phi = \frac{F'}{m + \frac{D'\delta'}{D\delta}}$$

$\frac{D'\delta'}{D\delta}$ represents the ratio of the depth of metal in each beam multiplied by its deflection, to the depth of metal in the solid beam multiplied by its deflection. But the deflections, as might have been expected from known laws, were nearly in the inverse ratio of the total depths of each girder; therefore the degree of flexure, and consequently the resistance to flexure in each, will be nearly as the depth of metal divided by the total depth of the girder, and we are thus enabled to obtain a formula for computing, approximately, the breaking weights of these girders, without first ascertaining their deflection.

Using the same letters as before, we have, for the resistance due to tension,

$$\frac{2a}{3l}\left(d + c + \frac{c^2}{d}\right) f;$$

and for the resistance to flexure,

$$\frac{2a}{3l}\left(d + c + \frac{c^2}{d}\right) \frac{\phi D}{d};$$

and consequently, for the united effect of the two resistances,

$$W = \frac{2a}{3l}\left(d + c + \frac{c^2}{d}\right)\left(f + \frac{\phi D}{d}\right).$$

I shall therefore conclude these observations by comparing the breaking weights computed for tensile resistance alone, and those obtained from the formula which includes the resistance to flexure, with the actual breaking weights obtained by the experiments, taking the value of $f = 18{,}750$ lb., and $\phi = 23{,}000$ lb.

Description of beam or girder.	Breaking weight if resistance depended on direct tensile strength.	Breaking weight computed by the formula, including the resistance to flexure.	Breaking weight as obtained by the experiments.
	lbs.	lbs.	lbs.
No 1	849	1890	1888
No. 2	1308	2567	2468
No. 3	1808	3287	3084
No. 4	2912	4659	4353
No. 5	2578	4935	5141
No. 6	3819	5533	5147
No. 7	4031	5919	6000

The accordance exhibited by the computed and the actual breaking weights, evinces the general accuracy of the formula, as applied to this form of beam; while these results, compared with those computed for direct tensile force alone, show how large a proportion of the strength of cast-iron, when subjected to transverse strain, is due to the resistance arising from the lateral action.

It will also be seen that comparisons of the relative strengths of different forms of section, calculated, as has been customary, on the assumption that the resistances are constant forces, or governed by a constant coefficient, must be entirely fallacious.

It was my intention to have included in this paper a similar investigation as to the position of the neutral axis, and the amount of the resistance arising from lateral action of the fibres in wrought-iron; but as the experiments will take some time to complete, and as the facts elicited in reference to cast-iron are of sufficient importance to render it desirable that they should be made known, I will reserve the examination of wrought-iron for the subject of another communication.

APPENDIX.

GIRDER No. I.

	Exp. No. 1.	Exp. No. 2.	Exp. No. 3.	Exp. No. 4.
	inches.	inches.	inches.	inches.
Depth	2·015	2·02	2·073	2·040
Thickness	·975	·98	1·030	·990
Area of section	1·965	1·98	2·135	2·020
Weight applied, lbs.	Deflection.	Deflection.	Deflection.	Deflection.
40	·015	·013	·014	·014
376	·145	·115	—	—
600	·203	—	—	—
712	·280	·233	·264	·244
936	·330	—	—	—
1160	·490	·420	·397	·414
1608	·725	·625	·579	·614
1664	·755	·655	—	—
1720	Broke	·680	·629	·659
1832	.....	·737	·679	·734
1888	.....	Broke	·699	·764
1916	.....	.....	—	Broke
1944	.....	.....	·734	
2000	.....	.....	·762	
2028	.....	.....	·774	
2056	.....	.....	·789	
2084	.....	.....	Broke	
Breaking weight, lbs.	1664	1888	2084	1916
Deflection with nine-tenths of breaking weight, inches	·643	·667	·699	·670

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GIRDER No. 2.

	Exp. No. 1.	Exp. No. 2.	Exp. No. 3.	Exp. No. 4.
	inches.	inches.	inches.	inches.
Total depth	2·54	·253	2.49	2·50
Depth between upper and lower ribs.....	·56	·55	·51	·55
Area of top rib	1·00	1·00	·97	·98
Area of bottom rib...	1·01	1·00	·99	·97
Weight applied, lbs.	Deflection.	Deflection.	Deflection.	Deflection.
40	·009	·007	·007	·007
712	—	·132	·132	·137
804	·199	—	—	—
1292	·304	—	—	—
1516	—	·302	·319	·312
1740	·414	—	—	—
1852	—	·372	—	—
1964	·489	·397	·426	·433
2076	—	·427	—	—
2188	Broke	·445	·479	·487
2300	.....	·479	·526	·532
2412	.....	·512	Broke	·550
2524	.....	·542	.....	Broke
2636	.....	·575		
2748	.....	Broke		
Breaking weight, lbs.	2188	2748	2412	2524
Deflection with nine-tenths of breaking weight, inches ..	·489	.532	·482	·516

GIRDER No. 4.

	Exp No. 1.	Exp. No. 2.	Exp. No. 3.	Exp. No. 4.
	inches.	inches.	inches.	inches.
Total depth	3·99	4·00	3·99	4·01
Depth between upper and lower ribs.....	2·00	2·03	2·05	2·04
Area of top rib	1·00	·97	·98	·98
Area of bottom rib...	1·00	·99	·98	1·01
Weight applied, lb.	Deflection.	Deflection.	Deflection.	Deflection.
40	·002	·002	·002	·003
712	·047	·040	·048	·058
1516	·104	·097	·102	·108
1964	·134	—	—	—
2188	·161	·155	·155	·148
2636	·199	·197	·185	·183
3084	·227	·227	·223	·218
3420	—	·259	—	—
3532	·269	·267	·255	·253
3756	·299	·282	·285	—
3980	·317	·312	·300	·303
4092	·329	·320	·307	—
4148	·336	·322	·313	—
4204	Broke	·327	Broke	—
4260	.....	Broke	.....	·333
4316	.....	.....	.....	—
4400	.. ...	.....	.....	·343
4428	.....	.....	.....	—
4745	.....	.....	.....	Broke
Breaking weight, lb.	4204	4260	4204	4745
Deflection with nine-tenths of breaking weight, inches ...	·297	·293	·282	·331

GIRDER No. 3.

	Exp. No. 1.	Exp. No. 2.	Exp. No. 3.	Exp. No. 4.
	inches.	inches.	inches.	inches.
Total depth	3·02	3·00	3·00	3·00
Depth between upper and lower ribs.....	·98	1·00	1·01	1·01
Area of top rib	1·03	1·02	·97	1·01
Area of bottom rib...	·99	·98	1·01	·97
Weight applied, lb.	Deflection.	Deflection.	Deflection.	Deflection.
40	·006	·005	·005	·005
712	—	·085	·085	·085
844	·113	—	—	—
1516	·216	·185	·197	·195
1740	·248	—	—	—
2188	·328	—	·297	·293
2300	—	·295	—	—
2524	·388	—	—	—
2636	·418	—	·363	·375
2748	·433	·377	—	—
2972	·483	·410	·423	Broke
3028	Broke	·425	·438	
3084	.....	·435	·452	
3112	.....	·437	Broke	
3224	.....	Broke		
Breaking weight, lb.	3028	3224	3112	2972
Deflection with nine-tenths of breaking weight, inches ...	·435	·402	·397	·371

GIRDER No. 5.

	Exp. No. 1.	Exp. No. 2.	Exp. No. 3.	Exp. No. 4.
	inches.	inches.	inches.	inches.
Total depth	4·02	4·05	4·05	4·04
Depth between upper and lower ribs.	1·04	1·04	1·04	1·00
Area of top rib	1·125	1·16	1·14	1·22
Area of bottom rib..	1·162	1·13	1·15	1·20
Weight applied, lb.	Deflection.	Deflection.	Deflection.	Deflection.
712	Deflections uncertain from imperfect fastening of the cord.	—	—	—
1516		—	—	—
2188		—	—	—
2290		·133	·148	·138
2636		—	—	—
2885		·173	·182	·178
3084		—	—	—
3445		·213	·221	·223
3532		—	—	—
3980		—	—	—
4005		·268	·270	·259
4428		—	—	—
4565		·313	·320	·308
4652		—	—	—
4705		·323	·335	—
4845		·348	·350	·335
4876		—	—	—
4927		—	—	—
4985		·348	Broke	·340
5008		—	.....	—
5050		Broke	.....	—
5125		.....	Broke	·355
5265		.....	.....	·365
5405		.....	.....	Broke
Breaking weight, lb.	.....	5125	4985	5405
Deflection with nine-tenths of breaking weight, inches ...	.....	·321	·313	·331

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GIRDER No. 6.

	Exp. No. 1.	Exp. No. 2.	Exp. No. 3.	Exp. No. 4.
	inches.	inches.	inches.	inches.
Total depth	4·02	4·05	4·03	4·06
Depth between upper and lower ribs.	2·52	2·55	2·56	2·61
Area of top rib	1·13	1·18	1·08	1·10
Area of bottom rib..	1·13	1·09	1·11	1·10
Weight applied, lb.	Deflection.	Deflection.	Deflection.	Deflection.
712	Deflections uncertain from the same cause as Experiment 1, No. 5.	—	—	—
1516		—	—	—
2188		—	—	—
2290		·130	·138	·138
2686		—	—	—
2885		·168	·186	·175
3084		—	—	—
3445		·205	·220	·222
3532		—	—	—
3980		—	—	—
4005		·251	·263	·272
4428		—	—	—
4565		·300	·313	·313
4652		—	—	—
4845		·315	Broke	·350
4876		—	.....	—
4988		—	.....	·365
5100		—	.....	—
5125	.....	Broke	.....	·378
5212	Broke	.....	.....	—
5265	.....	.....	.....	·382
5405	.....	.....	.....	Broke
Breaking weight, lb.	.....	5125	4845	5405
Deflection with nine-tenths of breaking weight, inches ...	.....	·298	·293	·340

GIRDER No. 7.

	Exp. No. 1.	Exp. No. 2.	Exp. No. 3.	Exp. No. 4.
	inches.	inches.	inches.	inches.
Total depth	4·05	4·10	4·08	4·05
Depth between upper and lower ribs.	2·50	2·51	2·51	2·52
Area of top rib	1·19	1·26	1·21	1·16
Area of bottom rib..	1·19	1·19	1·17	1·16
Weight applied, lb.	Deflection.	Deflection.	Deflection.	Deflection.
2290	·105	·105	·095	·090
2885	·115	·130	·120	·125
3445	·150	·160	·140	·160
4005	·185	·185	·180	·182
4565	·217	·215	·215	·210
5125	·255	·250	·235	·237
5405	·272	·267	—	—
5685	Broke	·285	·270	·272
5825	.....	·292	—	Broke
5965	.....	·305	Broke	
6105	.....	·310		
6245	.....	·320		
6385	.....	·330		
6525	.....	Broke		
Breaking weight, lb.	5685	6525	5965	5825
Deflection with nine-tenths of breaking weight, inches ...	·252	·297	·253	·246

Summary of the Experiments on Transverse Strength, giving the mean results.

	Depth	Sectional area.	Distance between the ribs.	Breaking weight.	Deflection with nine-tenths of breaking weight.
	in.	sq. in.	in.	lbs.	in.
Form of beam No. 1.....	2·015	1·965	.....	1664	·643
	2·020	1·980	.....	1888	·667
	2·073	2·135	.....	2084	·699
	2·040	2·020	.....	1916	·670
Mean	2·012	2·025	.....	1888	·670
Form of beam No. 2.....	2·54	2·01	·56	2188	·489
	2·53	2·00	·55	2748	·532
	2·49	1·96	·51	2412	·482
	2·50	1·95	·55	2524	·516
Mean	2·51	1·98	·54	2468	·510
Form of beam No. 3	3·02	2·02	·98	3028	·435
	3·00	2·00	1·00	3224	·402
	3·00	1·98	1·01	3112	·397
	3·00	1·98	1·01	2972	·371
Mean	3·01	2·00	1·00	3084	·401
Form of beam No. 4.....	3·99	2·00	2·00	4204	·297
	4·00	1·96	2·03	4260	·293
	3·99	1·96	2·05	4204	·282
	4·01	1·99	2·04	4745	·331
Mean	400	1·98	·203	4353	·301
Form of beam No. 5.....	4·02	2·287	1·04	5050	.....
	4·05	2·290	1·04	5125	·321
	4·05	2·290	1·04	4985	·313
	4·04	2·420	1·00	5405	·331
Mean	4·04	2·322	1·03	5141	·322
Form of beam No. 6.....	4·02	2·26	2·52	5212	.....
	4·05	2·27	2·55	5125	·298
	4·03	2·19	2·56	4845	·293
	4·06	2·20	2·61	5405	·340
Mean	4·04	2·23	2·56	5147	·310
Form of beam No. 7.....	4·05	2·38	2·50	5685	·252
	4·10	2·45	2·51	6525	·297
	4·08	2·38	2·51	5965	·253
	4·05	2·32	2·52	5825	·246
Mean	4·07	2.38	2·51	6000	·262

Experiments on Direct Tension.

No. of Experiment.	Sectional area at the place of fracture.	Last weight supported.	Weight with which the bar broke.	Remarks.
	inches.	lbs.	lbs.	
1	1·0506	18,560	18,840	A small air-bubble.
2	1·0557	19,680	19,960	A small air-bubble.
3	1·0100	21,360	21,500	A small air-bubble at corner very small.
4	1·0364	16,320	16,320	Honey-combed.
5	1·0301	17,440	17,440	Sound.
6	1·0403	16,320	17,440	A small air-bubble.
7	1·0150	21,640	21,920	Sound.
8	1·0200	22,200	22,470	Sound.
Mean...	1·0323	19,190	19,486	

Mean greatest weight supported, per inch..... 18,590 lb.
Mean weight which broke the bar, per inch..... 18,876 lb.

Considering the actual breaking weight to be between these two, and rather nearer the latter, when due allowance is made for the small air-bubbles, the mean breaking weight may be taken at 18,750 lb. per square inch.

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THE ROYAL ACADEMY.

At the general meeting of the Royal Academy, held on the 10th ult., the following Academicians were elected as President and Council for the ensuing year: *President*, Sir Charles Lock Eastlake; *Council*, E. M. Ward, S. Cousins, C. W. Cope, W. Dyce, P. MacDowell, F. R. Lee, J. R. Herbert, Esqs., and Sir R. Westmacott: *Auditors*, Sir R. Westmacott, W. Mulready, Esq., and Sir C. Barry.

The gold and silver medals have been distributed to the students as follows:—Gold medals—To Joseph Powell, for the best historical painting; and to J. Adams, for an historical group in sculpture. Silver medals—To J. W. Johns, for the best painting from the living draped model; to P. R. Morris, for the best drawing from the life; to J. Waite, for the next best drawing from the life; to S. J. Carter, for the best drawing from the antique; to G. A. Reeson, for the next best drawing from the antique; to H. Purcell, for the best model from the antique; to S. Lynn, for the next best model from the antique; to G. J. Miller, for the next best model from the antique; to Thomas Sich, for a perspective drawing; to A. H. Parken, for a specimen of sciography; and to J. S. Wyon, for a medal die.

The gold medal offered for the best design for an edifice for the exhibition of works of art, science, and industry, was not awarded, there being only one design sent in. There were no candidates for the silver medal offered for the best drawings of the great hall of Hampton Court Palace.

COMPETITIONS.

The design of Messrs. Pritchett and Sons, of Darlington, has been selected for Tottenham Cemetery. There were forty-seven competitors.

The Directors of the Rugby Town-hall Company offer premiums of 20*l.* and 10*l.* for designs and estimates for a Town-hall and public building, Rugby, to be sent in on or before 31st inst.

The feoffees of the common lands of Rotherham are desirous of receiving, on or before the 21st inst., designs for a grammar school, to accommodate 100 boys, at a cost of 500*l.*, and residence for the master, at a cost of 600*l.*

REMARKS ON FLOATING & FIXED LIGHTHOUSES.

By David Stevenson, F.R.S.E., M.Inst.C.E.

Sir—At the meetings of the Institution of Civil Engineers held on the 13th and 20th of November, at which I was not present, Mr. George Herbert's proposals for constructing Floating Lighthouses were read and discussed. I find from the Transactions, that on that occasion it was stated that the important objects fulfilled by the Eddystone, the Bell Rock, and the Skerryvore lighthouses, could be attained by means of a floating tower, with equal efficiency, and at a cost greatly inferior to the amount expended on these national works; and in proof of this, the actual cost of these three lighthouses was compared with the *estimated* cost of towers constructed on the new principle. These important sea lights having been thus specially and publicly referred to, I feel that no apology is necessary on my part for taking this mode of vindicating the proceedings of the Boards under whose auspices they were erected, as it can be satisfactorily shown that the objects which they serve could not be obtained in the manner proposed, and, therefore, no comparison of cost, such as has been made in the Transactions of the Institution of Civil Engineers, can in reality be justly or fairly instituted. Mr. Herbert's own wish in the matter, as expressed to me, is, that the subject should be fully canvassed.

I do not propose to discuss the important mechanical and nautical question, which is at once suggested by the difficulties to be encountered in maintaining in its site a circular body 80 feet in diameter, and 130 feet in height, moored on the foul and rocky bottom which surrounds the Eddystone, the Skerryvore, or the Bell Rock, amidst the seas to which it would, in any of these situations, be exposed. On this point I shall only say, that in dealing with floating bodies of such size and form, it is possible that even the resources of engineering, which seem to be regarded in the present day as boundless, may be found to have very marked limits prescribed to them, by the formidable and subtle elements of wind and sea, with which, in the case in question, they have to contend. But, in my opinion, such a discussion is altogether unnecessary, because, were the scheme proposed by Mr. Herbert feasible and advisable—which I am not prepared to admit,—it is not difficult to show that, in point of fact, the important objects now fulfilled by the lighthouse towers on these rocks, would not be obtained by means of the proposed floating tower, even if it could be successfully moored and maintained in its position.

It may be regarded as an axiom in lighthouse engineering, that a light exhibited from a *fixed* tower is preferable to one from a *light-ship*, and that a *fixed* beacon or perch is preferable to a *buoy*. No one who knows the subject will deny that a danger can be marked more precisely and advantageously by a sea-mark placed *upon* it, than by a mark moored *off* it; or that a more effective lighting apparatus can be adopted in a *fixed* tower than in a light-ship; or further, that while all lights or sea-marks exhibited from fixed structures may be regarded as *absolutely safe and certain in their exhibition*, all light-ships or buoys are the reverse of this, for their liability to drag their moorings and break adrift is notorious, and the danger to shipping arising therefrom is very great.

Although, therefore, light-ships and buoys ought never to be adopted where it can be avoided, still, it is at once admitted that there are situations where the difficulty of obtaining a foundation for a fixed structure renders their adoption absolutely necessary; and it cannot be doubted that all endeavours to improve the construction of light-ships and buoys should receive every consideration. This important subject has not escaped notice, for various efforts have been made, from time to time, to improve these sea-marks; and in 1851, Prof. Babbage, in his 'Notes on Lighthouses,' proposes to light up floating buoys, and in order to procure greater steadiness and safety, suggests that "the buoys should be attached to their moorings by rings fixed at the centre of resistance." But, with every perfection of construction and mooring, the proposition to place a *floating* and a *fixed* light in the same category, and to represent that the one is "as efficient" as the other, cannot be conceded; and this untenable proposition is laid down in the Transactions alluded to, where it is asserted that the sites of the Eddystone, Bell Rock, and Skerryvore might be as "efficiently" marked by the floating-light as by the present lighthouse towers; and the announcement is made that "practical men now seemed to think that the old system should not be continued, as the sea light-tower is capable of being moored in any depth of water."

In order to show that this proposition cannot be substantiated, I shall, in the first place, remark that a fixed tower such as that erected on the Bell Rock, the Eddystone, or Skerryvore, admits of the adoption of the most perfect apparatus which the engineer, with the combined application of scientific optical research and practical mechanics, can produce; the grand object being to intercept every ray of light, and to project a beam, unvarying in its characteristic appearance, towards the eye of the mariner. But no such advantage can attend the exhibition of a light from a floating tower, as its motion would render impossible the advantageous adoption of the most approved methods of illumination now used in lighthouses.

I may here remark, that from the observations I have made upon one of Mr. Herbert's buoys, which is moored in the Firth of Forth, I have reason to believe that the oscillation of the proposed light-tower will be much more appreciable than he anticipates. Mr. Herbert estimates that the pressure of the wind acting on the tower will cause it to incline 1° 28′ from the perpendicular. This can be determined by experiment only, but if in this estimate the action of the wind is viewed as a statical pressure, without regard being paid to the momentum of the moving tower; and, moreover, if, in addition to this (as I infer from the statement made to be the case), the action of the sea has not been taken into account, I should venture with confidence to predict, notwithstanding the peculiar form of the submerged base of the tower, that the united action of wind and sea, during storms, will produce a *cumulative* effect, and give the tower so great an inclination, as occasionally to take the light altogether out of the view of an observer at the horizon. The destructive result of this will be that, instead of a light with a decided and unvarying characteristic appearance, such as "stationary" or "revolving," or "flashing," being exhibited, we shall have a light altering its character with every heavy gale, when it is of most importance that it should not be mistaken.

In addition to this oscillation, there will undoubtedly be more or less of a rotatory or spinning motion of the tower round its axis, which is fatal to the adoption of "revolving" or "flashing"

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lights in floating towers, and thus in these important situations the advantages of the much greater power of revolving lights, as compared with those which are fixed, could not be secured. To insure the effective working of the delicate machinery connected with the revolving apparatus, and the lamps of a first-class light in a light-room, moving to and fro through a space of 6 feet, as admitted by Mr. Herbert, but which I think is greatly underrated, will be found to afford ample scope for the skill of the optician and mechanic. But, before the adoption of a floating tower can be recognised, some means must be contrived for adapting an *equally perfect* lighting apparatus to the oscillatory and rotatory motions of the tower in which it is to be placed—a problem whose solution is, I fear, impossible in lights of the first order. But this difficult problem must undoubtedly be solved before a floating tower is adopted, for it cannot be admitted that any circumstances could justify the use, in such important stations as the Eddystone, the Bell Rock, or the Skerryvore, or the Bishop Rock (now in progress of construction), of a less perfect means of illumination than that used in the lighthouses erected on the headlands and islands of our coast.

Another obvious objection may be stated, which happens to be very forcibly illustrated in the case of the Bell Rock. No one who is conversant with the circumstances of the case, will venture to affirm that that dangerous reef lying so directly in the track of shipping, whether bound for the Forth or Tay, or passing to and fro along the coast, could be effectually marked by means of anything short of a light erected upon it. Mr. Herbert has not, I suspect, fully considered the important question as to the site in which his proposed tower could, in the situation alluded to, be moored. It must be recollected that the "mooring ground" for a floating light, is analogous to the "foundation" for a light tower. It is in fact the primary inquiry, without a determination of which, based on *careful observation*, it is impossible to offer an opinion as to the practicability of maintaining the moorings, on the stability of which the safety of the structure must depend. The first question therefore is,—taking into consideration the nature of the bottom and the depth of water around the Bell Rock,—at what distance from the rock can a safe mooring be found? The experience obtained during the progress of the works is undoubtedly the best means we possess of approximately solving this question. The floating light used during the building of the Bell Rock was a vessel of 82 tons burden; and, after much consideration, and every care being bestowed on the subject, she was at first moored at the distance of one mile from the rock; but it soon became apparent that she could not ride in safety at that anchorage, and her moorings were ultimately removed to the distance of 2½ miles. It is further worthy of remark, that this vessel, although moored with all care (because on her stability the progress of the works mainly depended) *twice broke adrift*, and *was once run foul of by a vessel* during the four years she was in use. To what greater distance it might be necessary to remove before a proper depth of water and sufficient holding ground for the safe anchorage of such a tower as is proposed could be obtained, is a matter to be settled only by *careful survey*,—but it is obvious that it could not be nearer than the site of the floating light; and it surely needs no argument to prove that a light exhibited at the distance of between two and three miles from a rock, can never be represented as fulfilling "as efficiently" the object of a light-tower erected on the rock itself.

It is probably unnecessary to suggest further difficulties, but other objections may be mentioned as being peculiar to the floating light, and from which the fixed tower is in a great measure, if not altogether exempt. For example, the result of such a tower breaking adrift by stress of weather, or being driven from its moorings by a vessel striking it, would be the extinction of the light, and the almost certain destruction of the structure itself, and of its inhabitants; whereas with a fixed tower this cannot happen, and even should an ordinary light-vessel part from her moorings, sail can be set, and some chance is held out of working the vessel into a place of safety, which, indeed, has often been accomplished. Again, the floating tower cannot remain constantly at its moorings; it must necessarily be removed at intervals for the examination and repair of the bottom, and this in such a situation, for example, as Skerryvore, which is far removed from all mechanical resources, cannot be accomplished without great difficulty and expense. Its temporary removal further involves the necessity of its place being supplied by a duplicate tower and apparatus, for which I do not know that Mr. Herbert's estimates provide. Then the further question is raised, where can this duplicate tower be kept?—where can the permanent tower be placed, so that her bottom may be repaired?—and, above all, what steam-power must be at command, and what risk must be encountered, in towing these towers to and from their sites in such a situation as Skerryvore? But it is unnecessary to enter into greater length as regards these or other objections, as my object is not to point out defects in the proposed *floating* tower, but rather to show that such a structure, even if successfully constructed and safely moored, cannot in any sense be held to be a substitute for the Bell Rock, the Eddystone, or the Skerryvore lighthouses, which, once erected, remain for ever, are more efficient, and are subject to no such uncertainty as attaches to a floating structure.

On what, then, it is natural to inquire, does the recommendation of the proposed iron floating light depend? Not certainly on its greater efficiency, but exclusively on the smaller *estimated* cost of its construction. Nothing is said in the report of the Transactions of the Institution of Engineers on the very important subject of the cost of its future maintenance, which, from the number of men that would be required to take charge of so great a floating structure, the constant tear and wear connected with the moorings, and the expense attending its periodic removal for repair, would obviously be much greater than the cost of maintaining a fixed light-tower. The question of maintenance, however, is not adverted to, and in comparing the estimated *first cost* of the proposed floating light, with the actual cost of the existing lighthouses, Mr. Herbert has somewhat overrated the cost of Skerryvore, and has also, in all probability, overlooked the fact that the amount expended on that lighthouse includes a large expenditure connected with harbour accommodation, together with a signal tower and light-keepers' houses on the neighbouring island of Tyree; and that a similar expenditure is included in the cost of the Bell Rock. Now, in any statement in which the expense of these lighthouse towers is to be fairly compared with that of a floating light, it is obvious that these additional expenses should either be deducted or be held as common to any light, whether floating or fixed, which could be established at these places.

Whether Mr. Herbert has adopted this mode of dealing with the estimates, and has included any sum for a duplicate light to be used in the event of the permanent one breaking adrift or being removed for repair, I have no means of knowing; but according to my view of the matter, it is of very little consequence whether he has done so or not, because if by adopting *a more perfect means of illumination exhibited from a more advantageous site, with the absolute certainty of the due exhibition of the light not being interrupted by any casualty, it be admitted that a single vessel may be saved from shipwreck*, then the whole argument founded on the comparison of costs falls to the ground.

Are we, it may be asked, to spend millions of money on the construction of harbours of refuge at Plymouth, Kingstown, Holyhead, Portland, and Dover, for the benefit of our shipping, and to adopt an uncertain and imperfect mode of lighting such terrors to the mariner, as the Eddystone, the Bell Rock, the Skerryvore, or the Bishop, for the sole purpose of effecting a paltry saving of a few thousand pounds? I cannot believe that the importance of such works has been fully estimated by those who can entertain such a proposal.

Many are the vessels that have been lost, and the mariners that have met their graves, in consequence of these dangers. In one remarkable gale at the beginning of this century, seventy vessels were ashore at the same time on the coast of Scotland, the most of which got embayed in their endeavours to avoid the Bell Rock;—at Skerryvore, too, there are authentic records of no fewer than thirty-one vessels having been wrecked upon the rock. Whereas, now that permanent and powerful lights are erected upon these dangerous reefs, vessels steer for them with confidence as beacons of safety, and wrecks upon them are now happily altogether unknown. In these days of enterprise, when such sums are expended by government in harbours of refuge, and even by private companies in works for facilitating our internal communication—such, for example, as the High Level Bridge at Newcastle, or the Britannia bridge across the Menai Straits,—it is impossible to conceive that the country would be satisfied with anything short of the *most perfect* possible means of indicating to the mariner such dangers as these we have been considering, however high the cost of obtaining so important an end might be; nor can I conceive such a case to be a legitimate one for any compromise between *efficiency* and *economy*.

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In conclusion, I should not wish to be understood as opposing any obstacle to the improvement of floating lights and buoys: so far from this being the case, a buoy on the construction proposed by Mr. Herbert, and ordered by the Commissioners of Northern Lighthouses at my suggestion, was moored by me in the Firth of Forth, and has now been in use for upwards of two years. I am bound however to say that that buoy, although not exposed to very heavy seas or strong currents, does "not retain its perpendicularity," and does not show better (some are of opinion not so well) as the buoy formerly in use at the same place, which cost 23*l.*, whereas Mr. Herbert's buoy cost 102*l.* Still, however, I am not prepared to undervalue Mr. Herbert's investigations, nor to deny that for certain purposes and in certain situations they may be found exceedingly useful; and whenever I shall see an opportunity where they may be advantageously applied, I shall readily adopt them.

My only object in offering these remarks—which have been called for by the reference made to existing lighthouses—is to express my decided opinion, that whenever it can be proved that the erection of a fixed lighthouse on such important rocks as the Eddystone, the Bell Rock, or the Skerryvore, is by *any means practicable*, no question of economy can justify the adoption of what I must style the clumsy expedient of a tower *dependent for its stability on moorings*, and containing a light *less efficient than the ordinary sealights on the coast*, and even this imperfect light *situated* (*it may be*) *some miles from the danger which it is intended to indicate*, and on which the light ought to be placed in order to be useful.

DAVID STEVENSON.

84, *George Street, Edinburgh,*
December 10, 1855.

CONSIDERATIONS UPON SOME OF THE OBJECTS CONNECTED WITH ARCHITECTURE IN THE INDUSTRIAL EXHIBITION AT PARIS.*

By JOHN PAPWORTH, Architect.

WITH the same view that the results of investigating the productions connected with architecture in the Exhibition of 1851 were submitted to this Institute by the proposer of that step, he has now the honour of presenting his impressions as to similar objects in the Exposition of 1855; but the duty will this time be less completely performed; because there was an absolute impossibility of seeing (not merely looking at) everything in the short week which he could devote to it, as well as because under that circumstance the observer goes to such an Exhibition with impressions already formed, and cannot dwell long enough, except in very peculiar cases, upon single objects to modify the opinions with which he is prepossessed. To have dealt satisfactorily with everything relating to our profession in the various buildings would have required a corps of architects: the building contrivances appeared to be comparatively few in number, and collectively of little value; and therefore these remarks will be chiefly confined to the materials and the taste shown in decoration.

As a general idea of the contents of the Exposition, it may be stated that the number of exhibitors from—

France and its colonies amounted to about...			10,691
England	1460		
Its Colonies	985		
	——	2445	
Other countries		7574	
(Of which—Prussia, 1313; Austria, 1296; Belgium, 686; Spain, 568.)		——	10,019
			20,710
In 1851, about . .			17,000

The French classification of the Catalogue, as ought to be expected, is a refined one, but less suited to the ordinary observer than that of 1851. The Catalogue of 1851 was best fitted for an exhibition, that of 1855 for a museum; and something better might be made from a fusion of the methods. Those who understand the effect which is produced upon the public by the information that distinctions have previously been awarded to the producer of the articles at which it is gazing, will certainly regret with me that the English commissions did not add to the names of their exhibitors a list of previously earned distinctions. In the foreign divisions, the Exhibition medals and notices of Berlin, Berne, Dresden, Florence, Genoa, Gotha, Lausanne, Leipsic, London, Munich, S. Gall, Turin, Vienna, and of France, of all time that any exhibitor could claim, were paraded, and with no slight effect.

The *service du Batiment* comprehended the design and general arrangement of the buildings externally and internally. The chief names which appear in the official list under that head, are those of MM. Vaudoyer, as Commissaire; Rossigneux, as Commissaire adjoint, with the special care of the decoration; De Cremont, as architect, with the maintenance and decoration; and Trelat, as architect engineer, with the maintenance and decoration of the gallery (the annexe) on the quay. But I cannot suppose that it was owing to these gentlemen that so many architectural models and designs were not in the Exposition des Beaux Arts; an arrangement which caused several meritorious productions to be lost in the crowd of manufactures, and too many of them in the darkness which prevailed under the galleries. It would be in some degree unfair to compare the Oriental divisions, as to their cases, with works which have lately been executed here; they bore the impress of haste, although attractive at the first glance. Those to whom the idea occurred of placing the models from Sunderland (of vessels) in glass cylinders, deserve praise for the elegance which their invention displayed. The cases for the Glasgow goods were pretty, as were the stands for Bennett's watches and Claudet's photographs, but I guessed that they were French productions; as well as the Viennese cabinet of drawing materials and the handsome bookcases (Renaissance style) in the French department of stationery and printing; the stall of the Imprimerie Impériale, which had a back-board covered with green velvet and surmounted by a grand cornice with a bratishing upon it, was of course a French production. The very good Elizabethan case, a frame on brackets, for the woollen stuffs sent by the Commission Royale de l'Agriculture of Wurtemburg, was one of the best cases in the building; and the bamboo stall, 20 feet in diameter, of the Société Néerlandaise de Commerce, was pretty. The Prussian zinc work and the Austrian electrotyping will be named. The Australian bookcases, if made by Marsondet and Son from a design by M. Semper, were certainly not creditable to the skill of either the designer or the manufacturer. The English fittings in 1851 presented a great contrast to those on the foreign side, where government authorities did almost everything for the exhibitors, and massed their work in decorated and darkened apartments; but in 1855, the rule was darkness: and this was the more to be regretted, because a general effect of uniformity was produced at the cost of the brilliancy of the productions. The passages under the galleries were so narrow and so gloomy, that visitors were glad to keep out of them and stay in the body of the building, although that also had the effect of being filled with articles huddled too closely together. Very few market prices were affixed in the Exhibition, although information of that sort was invited; and it was impossible not to observe that where articles were marked with prices, and as "sold," they chiefly belonged to one of three categories, cheapness, trifling prettiness, and direct imitation of natural objects. Thus the cheaper objects produced by the electrotype process, although not in good taste—the library chairs (upon English models) from Hamburgh—and the English flower-stands, fenders, scrapers, umbrella-stands, knockers, and hat-stands were so marked; as well as a majority of the pretentious littleness which was to be seen throughout the building. It seemed that nearly all objects of direct imitation (as sculpture) from nature were sold, however they might be coloured, or whatever their material might be; for instance, a bundle of blue canes as an earthenware garden-seat, or three apparently leather cushions piled one upon another, in the same material; as well as umbrella-holders of birds, cupids, and dogs; plates of leaves; heads of animals as brackets, and many more. Next in attraction seemed to be the objects of every kind in the very simplest condition, such as the productions of Wedgwood; and following them the style de la Renaissance—rarely pure, but mixed with positive Gothic, or with servile copies from nature, or with both—was so prevalent as to seem the fashionable style. This mixture of various styles in a single work was so frequent as to create a feeling of dissatisfaction generally. For what it sent, Spain exhibited as little of this fault as any country; the tables and chairs from our Indian possessions were, as on a former occasion, remarkable for their adoption of styles foreign to the native school, and the spirit correctly infused into them; Belgian industry seemed to exert itself in mechanical rather than in artistic productions, but there was boldness enough in the works produced by Lalmand, of Antwerp, as models for the decoration of apartments, frames, &c. Another Belgian exhibitor submitted a cabinet costing 260*l.*, in a mixture of the Elizabethan and Nature styles, which was spoilt by the insertion of marqueterie representing perspective interiors; the works from the Netherlands were generally rococo but clever; while the Austrian and Prussian tastes were generally poor in effect. I am inclined to place as the first in the whole *Exposition des produits de l'Industrie* the contributions of the MM. Huber,—they chiefly consisted of a chimney-piece and frontispiece over it in the *style Le Pautre*; but there were other works from the same hand, such as the frame to Delepierre's flowers, which amply refreshed an eye fatigued by the general insipidity and poverty of the sculptured ornament in the Exhibition. Magnificence was also obtained in the bronze pedestrian statue of the late King Frederick William III. of Prussia, exhibited by the Institut Royal des Arts et Metiers of Berlin. The figure is represented in armour, inlaid with pseudo or late Etruscan ornaments in gold and silver; to this more marks of approbation were placed in my note-book than to any other work which I shall have to name; its effect was not quite paralleled

* Extracts from a Paper read at the Royal Institute of British Architects, November 5, 1855.

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though pursued with much taste by the ecclesiastical dresses from Brussels, the *manteaux de cour* of the Compagnie Lyonnaise, and the pseudo Etruscan embroidery of gold upon blue cloth, sent from England. The two Zuloagas of Madrid stand in my estimation in the next place, for the beauty of design and excellent execution of their armour and other objects in wrought and chased iron. The grand fountain by Barbezat, and the Greek candelabrum by Seigel (correct but not spirited), deserved especial attention; and the exhibition of fifteen sundials upon various parts of one pedestal, by Le Tessier of Plessier Grammoire, planted out in the open air where few could remark it, showed that an almost obsolete branch of science is yet cultivated in France.

The display of natural resources in stones, limes, bricks, slates, and woods, from Australia and Canada, was too important to be passed unmentioned, although I had no opportunity of studying them. I cannot refrain from expressing a hope that our government will see that it is its duty to endeavour to place those collections in England.

The further course of these notes may be divided into seven portions: the first consists of observations on the use of materials which come within the province of lithology, the second of observations on the application of metals, the third will treat of the use of wood; and then passing slightly over some products of the animal kingdom as applied in manufactures relating to building and decoration, we shall speak of the few building and other contrivances, of the models, and of the Exposition des Beaux Arts.

Putting aside the rich and numerous Australian collections of Mr. Clark and of Mr. Macarthur, and the good collections of small specimens of marbles from Portugal and Tuscany, it will be found that Greece and France produced the chief specimens of marbles. Porphyrite from Crocæa, Rosso-Antico from Damaristica and Cynopolis; Agate-breccia from Xilokeratia; breccia from the Taygetus; the amygdaloidal marble of Parori (Sparta); cipollino from Pyrgari in Lageia; the black marbles of Mantineia and Laconia; the green marbles of Sænus; the red marbles of Cape Tænarus; marbles and breccias from Nauplia; and alabastroidal marble (of which it is said that antique lachrymatories were made) from the island of Psythalia (Piræus); are the names found in the collection forwarded by the Greek government.

Derville and Co. sustain the honour of the French marbles by the collection of fine specimens, of no small size, shown in 1851; and their efforts were seconded by those of Millardet and Co., and of more than forty private exhibitors, of whom ten showed marbles worked up as chimney pieces. This number does not include an interesting collection of the marbles of Corsica: a translucent onyx-marble from ancient quarries at Aia-Teébalek, near Tlemcen (Algeria), a fine marble table of the grey red-veined marble, called rouge-royale, from the quarries at Franchismont, another of a marble from the quarries of S. Hubert, at Roquefort (Luxembourg), nor the ornamental columns suppled by Geruzet. Two productions should have stepped out of the pale of manufactures into the domain of art; one was a clock-case, 18 in. by 18, with three groups, costing 80*l.*, by Dubois; the other was a white marble vase, 24 inches high, and 12 inches in diameter, at the same price, by Margas; it was a beautiful, yet bold Roman design, with flowers extremely well executed. A chimney piece from the same firm was of nearly equal merit, and was the best of the French chimney pieces, which were of a higher class than those sent to this country in 1851, and showed that the mouldings of Vignola are the best suited to the coloured French marbles. There were also some very good second-rate chimney pieces, especially one which was marked as the pattern approved for the Mediterranean steamers. Besides the works of three other Belgian exhibitors, there were several chimney pieces exhibited by Leclercq, which were sold—in marbre Napoleon, a grey marble from Boulogne; in brocatelle brun from Dinant, and in Siena (at 84*l.*), the two last being better than a white Carrara marble (360*l.*)—The green Connemara marble, exhibited in the English division, appeared to advantage. Tuscany, as might be expected, stood first in the display of the inlaid work, called Florentine Mosaic. Mention should be made, for its size, of the great vase, 5 feet in diameter and 12 feet high with its pedestal, sent from Bagnères de Bigorre; and a stone, called Portland-stone, from the estate of Portland, in Jamaica, was shown, as turned by common wood-cutting tools. There is a similar stone in that island called Southampton-stone; the even texture and extremely clean arris which work in this material presents, would indicate the probability of its introduction here for decorative work. Wurtemburg sent a fine collection of building stones; Cologne Cathedral some work out of the mason's yard over-laboured and refined; and Austria a machine for making tubes of stone, a fallacy exploded here fifty years ago. Fourteen establishments contributed specimens of slate raised in France,—there was nothing in these collections remarkable; but I was unprepared for an exhibition of Italian slating: the slates from Sweden seemed of good quality. The English enamelled slate was a specialty. The French division contained about thirty exhibitors of cement and artificial stone. Portland and Roman cements would seem to be equally well known by name on both sides of the channel, and it is remarkable that only half that number exhibited limes, while only five showed plaster. The French scagliola-work appeared paler than such work in England; and, I may add, that my hearers will find that this paleness, the effect of white, is common to every branch of coloured continental manufactures. The vases, 30 inches high and 14 inches wide, in a Greek taste, made of chunam in India, were very remarkable.

To say that the twenty French and two or three other exhibitors failed miserably in their painted and stained glass, is only to express the opinion generally pronounced: it is easy to dismiss a whole class with a contemptuous sneer, but it is the duty of those who pronounce such a decision to be able, if not willing, to give the grounds of their decision. The following reasons guided my own judgment. In the class of flashed glass simply, the glass was washy, if there was any pot metal it had the same defect: the artists of the mediæval ages were so far fortunate that their material, *even when unstained*, was translucent, but only semi-transparent, and therefore looked substantial. Their followers enamel the present transparent glass in imitation of the dirt of ages, which they seem to fancy gives that *solidity* to ancient glass; the fallacy will be evident when it is considered that they seek a "transparent dirt," and that the semi-transparency of ancient glass is easily ascertainable. As a general rule, the modern works in the Exposition were too much paintings in the strict sense of the word; those artists who age their glass are obliged to cover it with enamel, to put shadows, hatchings, anything that will break the washy appearance of their material, or else to paint it entirely in enamel. This accounts for the prevalence among the exhibitors of imitations of the glass painting style of the fifteenth and sixteenth centuries, and the grisaille-work of succeeding times: but the public say "this is not the lustrous effect of old glass;" those artists who do not age their glass are told by the same public, "this is tame in comparison with old glass," and the public, without knowing why, is right in both cases. The host of ecclesiologists who besiege our glass painters, torment them fairly enough with the dilemma; from which some of the painters have ingeniously relieved themselves by the expedient of servilely copying some celebrated examples, which are of course irreproachable, and then retaliating upon their critics, "this is an exact copy of your ideal, can you object to it?" The critics, unless prepared to say that the painter cannot even copy, dare not raise a further objection; there is no blame to be thrown upon novelty of design, or excellence of drawing, and thus we may account for the prevalence among the exhibitors of imitators of the stained glass of the earlier periods. Coloured glass windows, to be really effective require few qualities, yet they are hardly to be obtained. Solidity of material I have already mentioned; purity of colour remains to be achieved: and when that part of the restoration is accomplished, good drawing will have to combat with the prejudices of this enlightened age, which praises Pre-Raffaellism and manufactures Pre-Cimabuity. What does the friend of Raffaelle and the pupil of Michael Angelo say? Cimabue was a pupil of the Greek masters, who executed "figures with senseless eyes, outstretched hands, standing on the points of their feet." He departed from the dry formal manner of his instructors, giving "more life and movement to the draperies; vestments, and other accessories, and rendering all more flexible and natural than was common to the manner of those Greeks, whose works were full of hard lines and sharp angles—and this rude, unskilful; and common-place manner the Greeks had acquired, not so much from study or of settled purpose, as from having servilely followed certain fixed rules and habits, transmitted through a long series of years by one painter to another down to those times, while none ever thought of the amelioration of his drawing, the embellishment of his colouring, or the improvement of his design or invention." But Cimabue drew from nature, a new thing in those times, says Vasari; and I may say almost unheard of in glass painting at present. It must suffice to say that some glass painting executed for the church of Notre Dame at Montbrison, having good modern figures with the drawback of bad colour, was exhibited, that the grisaille work was not bad, that an English modern window had the good idea of a lace glass with medallions of arabesque and Renaissance ornament, and that the prices of one manufacturer were per foot square, Grisaille and Byzantine work 4*s.* 9*d.*; modern pictures, 8*s.*; 12th and 15th century work, 9*s.* 6*d.*; 16th century work, 12*s.*; partly modern and partly ancient, 10*s.*; glazing, 7½*d.* or 8*d.*

The Portuguese porcelain and china ware was good; the great Sevres Etruscan vase was pale and washy, but remarkable for its size; the Austrian (Hungarian) china was designed with shocking want of taste; chairs of fine earthenware are, I believe, a novelty, they appeared in company with the renewal of a fashion long gone by, viz., the style of vases, ewers, &c., apparently tied in by a string, and left so to dry before firing, this fashion prevails in most French factories; very fine large vases and other utensils from Limoges, the superbly tasteful white utensils exhibited by Jacob and by Ristori, somewhat similar articles by seven other exhibitors, and some sharply modelled china by Schmidt, of Aix-la-Chapelle, formed a large and inviting field for the study of ornamental outline. The fine Swedish earthenware, Ridgway's wash-hand basin, "lavabo," as it is called on the continent (sold), the plain red and black pottery, the plain ware and Etruscan of Wedgwood (sold), and the fine earthenware stoves from Zurich in a severe Greek taste, excellently managed except for quatre-foils with Italian details, attracted considerable attention. The Swedish earthenware stove-cases were not good. The English pottery vases were equally conspicuous for wretched design and execution. The

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terra-cotta adjuncts to building purposes were numerous. Fine sharp architectural ornaments in this material were sent from Westphalia Winterthurm, and Wagram. Large terra-cotta articles, 24 inches square and good, were sent from Karamis in Belgium; and the largest figures in the Exhibition of this material were sent with ornamental works by Gossin fils, of Paris. Thiry, of Paris, and Miesbach, of Vienna, occupied places for figures, vases, balustrades, &c., only inferior to Follet, who sent excellent vases in a Moresque Greek style, and to Garnaud, who showed architraves, pretty vases and balustrades, his pattern book is worth inspection. Besides Clayton's brick and tile machine (bought by a member of the jury), which attracted great attention, and that sent by Whitehead, of Preston, there were twelve similar machines in the French division: five exhibitors sent French bricks, and small cement and beton blocks; and there was a large collection of Dutch bricks. Earthenware pipe tubes were not very numerous. The façade built up of his own bricks and tiles, by Borie, made a very pretty architectural display, and was a good lesson in ornamental brick-work. The Florentine tiles appeared to be very good. Madrid sent some pretty and large tiles; there were also very large tiles from Holland, foot tiles, double with cross holes and earthen sieves. France possessed fourteen exhibitors of tiles in different materials, as clay, glass, iron, and cement; and of varied manufacture, encaustic, and in low relief, for paving, &c., for stoves, &c., in the old Renaissance style, and for roofing in many patterns.

In the application of ornamental and sculptural art to the purposes of the goldsmith and silversmith, the English specimens certainly carried off the palm in the estimation of the visitors. Several called my attention to the display made by the Goldsmiths' Company, but it must be confessed that I saw with much more pleasure the exhibition supplied by Messrs. Garrard. A great improvement has been visible of late years in silverwork, especially in the styles of Adams and of Flaxman (Etruscan), and the statuettes are not so large. The piece of Moresque goldwork for the Queen commanded attention, as did also the cup made by Messrs. Watherston and Brogden, the last seemed more properly a piece of goldsmith's work, the other, from its style of design and size, appeared more valuable as a quantity of metal than as a piece of art, for the more nearly the two values approach each other, the more likely is the labour of the artist to be disregarded, or rather lost by the feelings excited by the material upon which he has worked. Where ornamentation only was employed, the French department, with its delicate and highly finished modelling, stood in the first rank, the parts being larger and the ornament smaller in proportion to the general design than in the works of other countries. I need only mention the Queen's candelabrum, exhibited by Messrs. Elkington, as a proof of the justice of these remarks, which apply in our own profession. Amongst the French productions was an ornamental tablet, valued at 4000*l.*, which appeared very satisfactory, and an object of somewhat similar character was furnished from Berlin. The silver gothic chandelier and the crosses from Spain were excellent. The French works generally were scarcely inferior to the rich productions of Maurice Meyer, except in perfection of execution, or to the jewellery-work of Beaufour Limonnier, except in regard of the generally good and simple taste therein exhibited.

A very large number of articles in bronze seemed to have affinity with the productions of the silversmith. It would be unfair to rank as works of mechanical art the copies, half the size of the originals, of the gates of the Baptistery at Florence, which we already knew; or the productions by Lechesne, which combined the style de la Renaissance with the direct imitation of nature. The busts exhibited by the Fonderie Barcelonaise, were the most sharp and highly finished bronze castings that I had ever seen, except those from the foundry of the Spanish Government at Trubia, in 1851; they were scarcely equalled by a well-modelled and cast font for Copenhagen, and by the works supplied by Kitschelt, of Vienna, in the usual mixture of the Natural and Renaissance style. The other works of importance in this compound were French, but the workmanship only was excellent. The well modelled and sharp, though not highly finished Renaissance candelabrum, by Labrune, and next to that the productions of Lacarrière, took precedence in the French division. Mention should be made of the Gothic church chandelier for fifty lights, exhibited by Carrier-Rouge of Lyons; it was, however, not well or steadily put together, and was hung too low to show to advantage.

There were many pretty portions of ironwork in the Exposition: for example, the standards to the Coalbrook Dale Company's stalls; and the signboards, &c., sent by Bouilliant Dupont and Co., of Evreux; but the first rank in ornamental ironfounding was occupied by a cast-iron pyramidal monument, in a good German taste, sold for 140*l.*, and by the gratings, the fans costing 3*l.* each, and the castings from embossed lace papers, exhibited by Count Stolberg Werningerode; next in rank would be the Eisenwer Lauchammer, Saxony: the works of Barbezat and Co., for iron and bronze castings, of Colas Frères, and of Muhl Wahl and Co,, whose works in the Place de la Concorde are so well known, stood highly in my estimation for taste and execution; with them may be named Eck and Durand, who exhibited, besides a kneeling figure of a princess of no great merit, several fine lamp posts; and Calla, who also sent six fine lamp posts. I particularly name the last two firms, because a member of our profession, whose name I have forgotten, was asking me before my visit the name of a manufactory in which he might find a good selection of handsome patterns for that extreme difficulty—a street lamp post. The best piece of plain French ironwork, on a large scale, was a field gate, in the open air out in a corner of the exhibition precincts; iron gates also in the open air, an iron fountain in the mixed styles of Nature and the Renaissance, and a pretty railing, claimed particular attention; but their interest was much inferior to the wonderful wrought-iron hinge-work, and similar productions, especially a piece belonging to M. Viollet Leduc, which, if modern, was the best of the sort that ever came under my inspection; the name of the producer is Boulanger, of S. Denis.

The Intendance Royale des Mines et Forêts du Hartz, Hanover, exhibited statuettes, 24 inches high, of the Apostles, for 15*l.* the set; and also a Caminofen, modelled by Halsemann, which were as excellent of their kind as the other productions from the same establishment were poor. Hanover also sent iron tubing, in lengths of 56 inches each, glazed externally as well as internally. The Swedish iron and steel work was fine, and the castings from Liège were superb in style and execution. Belgium showed iron plate, stamped with excellent effect, as in 1851, but the ironwork from the Netherlands was neither well modelled nor sharply and cleanly cast; the same bad taste as in its jewellery prevailed in the stamped iron plate from Prussia, which, mechanically speaking, was good. I was surprised to find Florence in the list of cities distinguished for iron casting,—two turnscrew staircases, one with wooden treads, a superb balcony-cantilever, a lamp-bracket, and a handsome railing, were all of at least the second rank. In 1851 notice was taken of Austrian iron post paper, in the shape of remarkably thin sheet iron, and of Prussian zinc, not thicker than common writing paper. This year France has added brass as thin as tissue paper. It may be a question whether covering woodwork, for example a cornice, as at Berens and Blumberg's in St. Paul's Churchyard, with these substances, would be in conformity with the use of fireproof materials required by the Metropolitan Buildings Act. The collection of English ironwork was not satisfactory. The design of some of the Canadian stoves, and the carving of their patterns, with castings by Rodden of Montreal, were superior—but their joiner's ironmongery inferior—to the average specimens in England. Some of the English firms which ranked highest in 1851, did not support their previous fame. The chairs exhibited by the Coalbrook Dale Company, in a sort of Moresque Renaissance style, were tolerably good; and the pair of gates, priced by Cottam and Hallen at 240*l.*, were fair but flat. The best of this class was Bailey's fine grille. About a dozen plates of iron produced among seven exhibitors by various processes were from $\frac{5}{16}$ to $\frac{1}{4}$-inch thick; from 1 ft. 4 in. to 6 ft. 6 in. wide, and from 14 feet to 39 ft. 8$\frac{1}{4}$ in. long; between 65 feet and 136 ft. 9 in. superficial, and from 692 lb. to 3417$\frac{1}{2}$ lb. in weight.

In zincwork, France was chiefly represented by the Vieille Montagne Company and by Baudoin. The latter firm exhibited a handsome hipknob, 4 feet high, price 16*l.*, sashes, ornamental roof-work, vases, &c.; but the Prussian zinc-work was, as heretofore, more agreeable to me. The pretty—whatever a great English authority might think of the application of certain outlines and details—gilt and painted zinc Moresque stall belonging to De Diebitsch, of Berlin, was full of apparently pretty things. The minor works in metal deserving mention consisted of wire seats and tables for use in gardens; square-bodied patent metal tubes; the imitation of bronze articles submitted by Dubois and Soulais, which were good in execution but selected with less taste than was desirable; and the electrotyped frames of the productions sent by the Austrian Imperial Printing Office.

The collections of useful and ornamental woods were numerous and magnificent; Tuscany, the Papal States, Spain, Venezuela, the United States, Sweden, and Canada were among the minor exhibitors; Greece and Australia were among the largest. Among various treatments of wood were injection; antiocorrosive coating; large panels rendered invariable for painting, coach-making, and furniture; and thin sawn wood (*feuilles de carton bois*); and Bavaria showed pine wood cut into 30 leaves in the inch, and mahogany cut into 11 leaves in the $\frac{1}{4}$-inch. The number of exhibitors of wood carved as decoration or furniture was very considerable (214). England sent the greatest number 56, France 47, Holland 18, Denmark 15, Tuscany 15, Sardinia 14, Sweden 10, Norway 7, Prussia 7, Belgium 6, Bavaria 4, Switzerland 5, Spain 5, Austria 2, Baden 2. The carving bestowed upon these works was in general mechanically good; the taste of the ornament is all I shall have to mention after noticing the delicate workmanship of Knecht, Planson, Lagnier of Bordeaux, Guéret, Tweedy of Newcastle, and Wallis of Louth. The Canadian furniture, with much introduction of natural objects, was excellent; the rocking and Windsor chairs all sold from their cheapness; the very handsome wardrobe, by Roehr of Prague; the light and excellent chairs and furniture by Thonet of Vienna; the ingenious expanding table by Boulfray; the Piedmontese billiard table, of a good sarcophagus design; and a chimney piece, by Fourdinois, costing 1920*l.* leave me to speak of the expensive bookcases, wardrobes, and sideboards, at prices varying from 800*l.* to 220*l.* Guala of Turin, exhibited a good pattern of a carved roof, and handsome handrails; Ringuet le Prince, of New York, exhibited a sideboard in the Renaissance and Nature styles, which had much merit. Zora, of Turin, exhibited some of the best chairs, and other good furniture, with which

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might be ranked the Florentine and Sienese works. Cruchet's fine frontispiece of game, Jeanselme's bookcases, and Beaufil's, of Bordeaux, walnut bookcase, were probably those seen in 1851. The Emperor had purchased three cabinets or bookcases, and had certainly been well-advised. The English productions, scarcely visible under the galleries, the French Renaissance walnut-tree bookcase by Klein, the bed and glazed wardrobe, by Semey, the walnut bookcase of Wieber, Pitetti and Co., and the pear-tree escritoire by Gueret, who is also mentioned as a carver of small articles being imitations of natural objects, like Michaud and De Villeneuve, who send a frame exhibiting the best wood carving of the natural style in the French division, conclude my list of furniture.

The merit of design in pianofortes rested with Hughes and Dunham, and Hopkinson, in the English division; and with Hornung and Muller, and Sorensen, of Copenhagen; they sent pretty cases, and the best as being simplest: but the Swedish cases were trifling, like those from Hamburg, which is surprising.

The eighteen French, six English, and some Genevese manufacturers of paper-hangings, did not present anything which seemed peculiarly meritorious; for mere paper, Pirie, of Aberdeen, was considered by some French connoisseurs to show the pearl of the Exhibition. The specimens of parquetted floors, from all parts of the continent, at about 10*d.* per foot superficial, were numerous as might be expected; it is hardly safe perhaps to judge from the examples exhibited, but those made of small bits split terribly, large bits stood better. The employment of caoutchouc, which was honoured by a medal in 1851, has considerably increased. The taste displayed in picture frames and pretty ornaments, polished like jet, was of a high order, and creditable to the exhibitor Charles Goodyear. Ivory, as a material for carving, appears to excite much attention in France—the large Renaissance casket, by Moreau, deserved much praise; as did the Renaissance casket, 9 by 4, in one piece, by Hebert, costing 40*l.* In ivory turning no difficulties seem to exist; unless a mistake has been made, one cup was 6 ft. 7½ in. high, by 1 ft. 11½ in. diameter. At least ninety-eight exhibitors in wood or ivory turning, and thirty-six others in fans, canes, sticks, parasols and umbrellas, sent their productions; among them, Collette was really conspicuous for the artistic merit of his sticks, finely carved and headed, at the price of 8*l.* each. There was one remarkable exhibition of leather for decoration. Dulun asserts his enrichments to be 200 per cent. cheaper than wood; his hangings cost from 5*s.* 6*d.* to 12*s.* 6*d.* per yard, according to their richness; and chair coverings 4*s.* to 7*s.* each. An imitation of these hangings was charged at 1*s.* 6*d.* per yard. The imitations of wood in graining from Toronto were excellent, from France good, but both Moxon and Kershaw stood in the first rank for marbling and graining. Two French tradesmen observed that the work of the latter (grained and imitation inlaid doors) had no chance against so much that was real, and that the work of the former only required patience, which no Frenchman would condescend to give to the work. Two hydro-fuges, besides Claudel's coating for decoration and fresco painting (apparently excellent); mastic hydraulique, Laurent-Machabée, 45, Rue de Vaugirard (also apparently excellent), and the process of Lebrun of Moissac, viz. "ineffacable colouring on stucco" were worthy of observation.

Seven French exhibitors supplied draining instruments and tools; seven others exhibited sawing and mortising machines. The great crane employed in the execution of the building, and two machines for breaking stones (*mortier concasseur*) for roadways, were simple and ingenious. The *psalizometer* was a sort of bevel equally useful in the *coup des pierres*, or in the *coup des draps*, for which last it was invented. The Austrian carpenter's bench was not a bad one; it would be worth the trouble of some society to have one in England for exhibition to the builders, the price of one highly finished being 1*l.*; it was exhibited by Werthiem of Vienna, whose collection of tools was very complete and interesting; his catalogue should be obtained, for everything seemed of the most improved shape and of good quality. The Prussian tools were far inferior in appearance. All the American moulding-planes were sold; the profiles would have been good if they had not been so very mean; this is a vice which seems prevalent in the modern buildings at Paris, I mean those erected since 1840, as they appear to be treated with less boldness of projection in details every year; this may account in some degree for the mania of polychromatization. The Canadian joiner's work looked at first sight fair, but on consideration it was machine-work to a considerable extent; and the material required to be cleaned, according to our notions, before the priming-coat could be laid. The stuff seemed rasped, with little hairs of the grain of the wood standing out. A 1¼ four-panelled door with ogee moulding on one side, and a 5-inch two-faced bead ogee and square architrave with plinth, was marked 15*s.*, which has been called very cheap by some periodicals ignorant that a better article, under the same conditions, can be got here for the same price. The two best examples of French joinery were contributed in a window, by Bernard Hoen; the other in a rachetted bookcase, made by the pupils of the Institut Imperial des Sourds-muets at Paris. Three French manufacturers had given their attention to scouring-papers; granite, lava, emery, glass, flint, silica, and porcelain are the articles employed upon cloth or paper for polishing. As to large bellows, the only specimens I saw were made in England. The door-springs by Renaud, of Paris (rue Petrelle, 22) appeared to me to deserve the attention of our manufacturers; they occupied only the position and the usual appearance of the hinges. The merits of the different French systems of sashes and sash-fastenings, with sun-shades, both internal and external, were beyond the passing observation of a stranger to their usual mode of manufacture.

There was considerable novelty and merit in the seven systems proposed for the construction of wooden pulpit staircases or vices. They were on three principles, viz., with a solid newel, like the usual iron ones, with an open well-hole, the carriage being an iron plate; and with a continuous writhed string, which was the most curious and the best looking; the steps had no risers shown in the full-sized specimen exhibited. A double staircase was, if I remember rightly, also exhibited.

The prices of old bells re-cast seemed to be 3½d. per lb., of new bells 14d., and 2d. additional for their mountings. There were several expensive contrivances of wheels and pinions for facilitating bell-ringing; but Besson's bells were very remarkable on several accounts. He claims the merits which follow on the adoption of the late improvements of the bell being turned in a lathe; on the power of lengthening or shortening the clapper, and on the details of hanging the bell; but the portion which most engaged my attention was the gudgeon and its seat. The seats, *coussinets articules*, as he calls them, from 1*l.* per pair upwards, are a variety of the knife-edge balance; the ease which they give to the ringer is such, that with one finger on a whipcord fastened to the wheel, he rings a bell of about 6 cwt.; and on asking him the number of men requisite to raise a bell of 15,000 lb., he answered that two could do it if the bell were on these seats. Bells mended by Delcroix Mangin of Chalons-sur-Marne, and bells cast of steel at 8d. per lb. attracted much notice.

The employment of resin in making artificial stone; paper covered with composition to imitate slate, stone, &c.; and calico soaked in marine glue for roof covering—were French inventions; while asphalted millboards, said to be incombustible, and artificial slate for drawing boards, were Austrian productions. Publicans' fittings and asphalted felt were only forwarded from England. A cap for smoky chimneys from Poitiers; thirteen French waterclosets, which I did not examine, as they were in the division of Pharmacy and Surgery; three fire-escapes, in the shape of ladders, and one in that of a box of carbonic acid gas; two street-sweeping machines; as many chimney-sweeping machines; and speaking-tubes (which appeared to be a novelty and source of amusement to the French public) complete the subjects of this class which I have to name.

There seems to be no good reason why all the architectural drawings, if not the models, should not have formed part of the Exposition des Beaux-Arts. The design of a college at some place in Canada, by Kivas Tully; Welland County Court House, by J. Gillespie; and the City Hall at Toronto, which give evidence of the existence of a really good school in Canada, were hardly distinguishable in the darkness under the galleries of the Exposition de l'Industrie. The architectural models were almost entirely from France and England. The former, from the stores of the Ministère de l'Agriculture, du Commerce et des Travaux Publics, contributed Pont Napoleon over the Seine at Berry, built by Couche, for a railway as well as for carriages and passengers; Pont d'Arcole over the Seine at Paris, built by Oudry; Viaduct Bridge at Dinan, over the Rance, designed by Reynard, built by Mequet and de Gayffier, Railway Viaduct Bridge at Tarascon, over the Rhone, built by Talabot; another at Arles, over the Durance, built by Talabot; another over the Bouzanne, built by Borrel; another at Asnières, over the Seine, built by Flachat, and the Aqueduct of Roquefavour over the Are, built by Montricher. Private exhibitors contributed the model of the metal cupola of the Observatory at Paris, as in 1851; the viaduct of five arches, each 131 ft. 3 in. span over the Rhone at Lyons; Marseilles and Toul Cathedrals; the Church of S. Jean des Vignes at Soissons; and Polonceau's Roof over the station at Versailles, of the Rive Gauche Railway. From Switzerland there were some pretty models of chalets. In the English department there were models of the New Market at Holloway, by Bunning; the Victoria Bridge (stone) over the Clyde, at Glasgow, five arches, 1851-54, by Walker and Burges; the Suspension Aqueduct at Stanley, near Wakefield, and a Bridge at Leeds, by Messrs. Leather; the moveable Viaduct at Ulverstone, and a Bridge by Brunlees; and Mr. Lassell's iron revolving Observatory Dome, at Bradstones, near Liverpool. India sent the model of the Roof-muttee Mosque, at Ahmedabad(1499 A.D.) From Canada there were several models, viz. the Brock Monument, on Queenstown Heights, Western Canada, 185 feet high, which is a composite column, by William Thomas, architect, at Toronto; the Court-house at Montreal, and the celebrated Box Bridge across the river St. Lawrence at Toronto. Besides these there were several specimens of ingenuity—such as an idea of ventilation by means of ceilings decorated with deep girders; a balustrade and stirrup for an iron bridge; a design for a railway-station roof, made with trellised laths caught in by rods everywhere, apparently good for iron construction; and the fine model of the roofs, 60 feet square, over the workshops of Nepveu and Co., at Clichy. This model, presented to the Conservatoire des Arts et Metiers, where it should be studied by travellers, was the only example in the Exhibition of the modern style of framing roofs as practised usually in England.

Several self-subsistent pieces were in the collection: it is to be

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regretted that they were so deficient in success. Among the best was one altar and doorway, by Gates and George, of Caen; a fountain aviary, by Tahan; a surprising open oak-work shrine, costing 200*l.*, by Dumon, of Bruges, in a German-Gothic style; and a rich German Gothic, but badly put together, oak altar, by Goyer Frères, of Louvain, at the same price. The frightful pulpit (oak), labelled as executed under the superintendence of the Abbè Choyer, Directeur d'un Etablissement de Decoration Religeux, at Angers, accompanied by an altar nearly as bad, were very inferior to the other French altars; the pulpit and canopy with winding stairs poorly executed and not in the best possible taste, costing 520*l.*, by Veneman, of Bois-le-Duc; or the oak altar, second rate, by Prang, of Munster, price 140*l.*; all of which were eclipsed by the very correctly detailed altar-piece of copper and silver gilt, designed by Viollet le Duc, I think for Bachelet. The terra-cotta altar-piece for the church of Maison-Rouge (Seine et Marne), by Debay and Co., would be placed by me in the first rank of those exhibited.

A complete copy of the *Bauzeitung* I did observe, but there was no English journal relating to our profession—no *Civil Engineer*, no *Builder*, not even an *Art Journal*. One architectural publisher, of Berlin, sent upwards of fifty works, but no other exhibitor emulated him: I presume these books were only admitted as specimens of typography; they included the Prussian Government work on decoration, and Salzenberg's Agia Sofia. Sixty-four French designers for manufactures were allowed to exhibit their skill, and they furnished one of the most interesting of the galleries, in one of the most conspicuous places; four Belgian and one English decorative artists were lost among the goods in the backgrounds of their respective countries. Such is the difference to be expected between the two leading countries which manufacture decoration; in one the Empress has the *designs* of her shawls and dresses submitted for approval; and the Emperor purchases the only good thing, but it *was* good, in a poorly-furnished stall; in the other, the decorative arts are so miserably represented by a government department, that it was painful to see how ill-judged an attempt had been made.

This was one of the quinquennial Exhibitions at Paris; as the Exposition des Beaux Arts, due in 1854, was postponed to the present occasion. While the other countries of the world only sent forty-five subjects (and of these only eleven were executed designs), France sent forty-three archæological subjects, twenty-seven restorations, nine projects, and four executed designs, in all eighty-three works; and England sent ten archæological subjects, eleven restorations, twenty-four projects, and fifty-two executed designs, in all ninety-seven subjects. I must add to the French list twenty-six sets of the Grands Prix, making 109 subjects, and giving a total of 251 in the Exposition, where our countrymen held the first rank as designers, practitioners, and artists in water colours.

In the consideration of the awards of the juries, we must recollect that great self-gratulation was originally expressed by the officials at the working of the French system as to awards, which system "*appelle a les recevoir les contre-maitres et les ouvriers.*" I shall be glad to see if that system works well as regards architecture, and shall be joyfully surprised to see if any of our English architects have mentioned conscientiously the *contre-maitres* to whom they have been indebted for such pretty pictures as those sent to Paris on this occasion. Not being an exhibitor myself, I can regret that no academical designs of the present time were sent from England; there are enough in London, to set with humble confidence beside the twenty-six French Grands Prix: but, when I asked in this room the Government Committee whether such designs would be received, and recommended that if they were not, a circular should be addressed to certain individuals, you will recollect that I was lectured for the presumption of the advice. The result has been, that the Committee did send the circular, but did not compliment the proposer of it with a copy; and the French themselves want to know, why the representatives of grand art in English architecture have not exhibited? Those who know anything of the working of an international jury, will comprehend that the disposal of rewards is not likely to be satisfactory to the English manufacturers and artists. Not satisfactory to the manufacturers, because they rarely condescend to the trickery of putting forward their goods at feigned prices; because they trust, without puffing, to the reputation of their firms and to the connection which belongs to it; and because, when they do see something better than their own, they confess the fact with a readiness which does England no little harm upon the Continent, although it is much to their credit as honest men. Not satisfactory to the artists, for reasons common to them and to the manufacturers. Among both classes of labourers abroad, those who deserve well of their country, receive decorations, which form a visible distinction between vulgar capital and talented industry (in one or two countries these distinctions cannot be conferred by the government of its own accord); and foreigners are not aware that Englishmen cannot obtain permission to wear even the decorations received from other countries. So that when our artists and manufacturers visit the Continent, especially upon an occasion like the Exposition, their foreign rivals glance at the breast of the Englishman to learn at once the mental standing of their guest. No cross, no ribbon, no medal offers itself to view, and they naturally say to themselves, this may be a good man and a rich man, but he has no talent or he would have been decorated like ourselves. I would be thankful to believe that Sir Charles Barry, or Professors Cockerell and Donaldson, as an acknowledgment of their art, ever wore the gold medal of this Institute abroad, even on special occasions. I believe there are only five Englishmen who at present can show a royal medal for art. All the commendations which you have heard may not be confirmed by those of the juries; but I expect, that the international juries will bestow their medals for extraordinary cheapness, for extreme beauty of design, for soi-disant extraordinary inventions, and for previously achieved distinction: in which case, we shall probably see, that upon sufficient explanation from their friends, those of our countrymen who obtain the chief honors, will be those who have been knighted at the cost of 300*l.* to themselves, after their worldly success would enable them to disregard so expensive a mark (of royal—not national—approbation,) which is hardly understood at all abroad as being far more than equivalent to the cross of an order, and certainly does not always fall on the right shoulders.

It may be asked, what good has been derived by our profession from these exhibitions? Whatever may be the tenor of the awards of the juries, I believe that two things are clear results. Our employers have had the opportunity of seeing in that France, which is supposed to be their leader in fashionable knowledge, that architecture is not a trade, but one of the beaux arts; and ourselves have had the opportunity of making such acquaintance with the French architecture of the present day, as to demolish much of the tendency to self-abasement before it, which has been too common in this Institute.

PRELIMINARY REPORT ON SOURCES FOR THE WATER SUPPLY OF DROGHEDA.

By JOHN NEVILLE, C.E., M.R.I.A.

THE population of the borough of Drogheda, according to the Census of 1841, was 17,300 persons, residing in 3,654 houses; and according to the census of 1851, it was 16,845 persons, residing in 3309 houses. The former gives an average of 4-46 persons to each house, and the latter 5 persons, very nearly. For the purposes of this report, it will be, however, safer to assume the population at 20,000, and the number of houses at 4000, which gives an average of 5 persons to each house.

The number of gallons of water required for the supply of each person, including all collateral uses, has been differently estimated, and varies in almost every town, and even in the same city. London, for instance, when supplied by different companies and under different systems. 44 gallons per head, per diem, were supplied by the several companies of London in 1853, while evidence has been given to show that the actual average consumption for all purposes did not exceed 10 gallons per head, per diem; the remainder having been wasted under an imperfect system of distribution. It is asserted that when the supply is 25 gallons per head, per diem, that 5 gallons of it is used for purposes requiring filtration, 10 gallons for purposes not requiring filtration, and 10 gallons wasted, or two-fifths of the supply. As there must be a considerable loss under even the best system of supply, I shall assume, for the present, with the Board of Health, that a minimum supply of 75 gallons per house, per diem, or 15 gallons per person, per diem, is necessary for your town; and assuming the number of inhabitants, in round numbers, at 20,000, we get 300,000 gallons for the daily supply to be provided on these data, or about 48,000 cubic feet. This is equivalent to a supply of 2000 feet per hour, 33⅓ feet per minute, five-ninths of a foot, or 3½ gallons per second, very nearly. The result of the calculations founded upon this preliminary result can be modified, according as the supply which may be deemed necessary shall be more or less than 15 gallons; and, as will be easily perceived, this increase or decrease will affect the final results in exactly the same way as a proportionate increase or decrease of the assumed population of 20,000.

The next consideration is, what size of channel is requisite to convey this quantity of water to a distributing reservoir in your town or its vicinity, assuming it is only to be had from a distance; and here it is necessary to take into consideration the general rate of inclination at which the channel can be brought from the supplying source to the distributing reservoir; for, with a fall of 12 feet per mile, a circular channel of little more than 7½ inches in diameter—the water flowing full—will give the requisite supply of 34 feet per minute; while a pipe of 13 inches in diameter is necessary, with a fall of only 1 foot per mile, to give the same discharge. If, however, we require a double supply, we have only, *cæteris paribus*, to increase the size of these channels by one-third, and this simple rule will, under your cir-

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cumstances, be of advantage in considering the ulterior enlargement of any of the proposed channels of supply.

The first source from which a supply can be derived, and which naturally presents itself, is Tullyescar stream, as delineated on maps 2 and 5 of the accompanying atlas, and which may be perceived as it passes alongside the Belfast-road, in the vicinity of Killineer house. By means of a new cut of less than half-a-mile in the townland of Killineer, the waters of a stream to the west, which passes under Waterunder bridge, on the Collon-road, and Drybridge, on the Townley-Hall road, and discharges itself in the Boyne, can be united into those of Tullyescar. The waters of these united streams can be again increased by some small feeders, which may be collected and added to the foregoing supply, near Mr. Harpur's pond, above the junction of the townlands of Moneymore, Mell, and Killineer, about which latter place the land is nearly at the level of the high ground over Drogheda, in the vicinity of Hardman's garden, which is about 114 feet over the level of the trackway for canal boats near Ball's grove. It is not necessary to enter into the extent of catchment basin which supplies these streams, nor into the average annual fall of rain, nor into the portions which escape by filtration to supply lower sources, nor into the portion which passes off by evaporation; all these heads may be made subjects of useless display and of uncertain inferences, while the actual quantity of water flowing in them is capable of admeasurement, and becomes, after all, the only safe test of their capability and supply. On the 31st of April last, the whole quantity of water flowing in the Tullyescar stream, along the turnpike road, did not exceed $3\frac{1}{10}$ cubic feet per minute, or less than one-tenth of the minimum supply assumed as necessary for your town. On the 14th of June,* the quantity flowing in the Tullyescar stream, taken at the same place, was nearly 4 cubic feet per minute, and that of the Waterunder stream 8 feet, making together 12 cubic feet, or only one-third of the minimum supply. On the 13th of July, the quantities flowing were as follows:—

	Cubic feet per minute.
In Tullyescar stream, taken below the junction of small stream between Moneymore and Killineer...	5·5
Waterunder stream, in Killineer townland	6·5
Total	12·0

which is little more than one-third of the necessary minimum supply. On the 25th of July, after some heavy rain, the whole quantity flowing below Mr. Harpur's demesne was 8 feet, and that flowing in the Waterunder stream 9·4 cubic feet per minute, making together 17·4 cubic feet.† Now, as February, March, April, and sometimes May, are the driest months of the year, or those within which the least quantity of rain falls in this country, we may assume with safety that for six months in the year the united supplies from the sources in the vicinity of Tullyescar do not exceed more than one-third to one-half of the assumed minimum supply. And hence, in the event of these sources being fixed upon, there will be a necessity for collecting any surplus which may accrue during the wetter months into collecting reservoirs, which, in order to command the heights at Hardman's garden, must be, at least, as high up as the pond in Mr. Harpur's demesne, in the townland of Killineer, have a surface of about ten or more acres, and average about 20 feet deep.

It is true that the natural basin in the townland of Moneymore may be made available for the purpose of a collecting reservoir; but the bottom of this basin is 25 feet below the level at Hardman's garden, and there would be this loss of head in supplying the town; besides which, the extent of embankments, fencing, and cost of land, would involve considerable expense. Nor do I know of any effectual means of fencing such a reservoir within a reasonable expenditure, so as to prevent cattle—often with the assistance of the owners, as it may be presumed—from getting into and wallowing in the water during the summer months, and injuring, in every way, its purity. The objection as to cattle muddying and injuring the water during the summer months, applies nearly equally to collecting reservoirs higher up; but all such reservoirs retaining the water for more than one-half or a considerable period of the year without movement, and thereby encouraging animal and vegetable growth, are objectionable for water supply, unless when of considerable depth and covered over—essentials which are here out of the question: yet in immediate connexion with properly constructed filtering beds, and a covered-in supply basin; these reservoirs could be made available for a pure supply.

But it may be inquired, "would the surplus during wet months, be sufficient when so collected to make good the deficiency during the dry months?" I think, scarcely. Taking the minimum supply per diem, already referred to, it appears that there is a deficiency of two-thirds of the whole quantity required, making about 21 feet per minute, continuing for 183 days at least. At present, I have not data from which to derive the number of days during which there would be the requisite supply, and the number of days during which there would be a surplus, but, in the absence of information which can only be obtained during the coming autumn and winter, it is not too little to assume that the surplus would balance the deficiency during the remaining 183 days. This would still leave the necessary supply during the summer months deficient by nearly two-thirds. Finally, assuming that the surplus passed off suddenly, during and immediately after heavy rains, and also the ordinary flow during the wetter months, are together five times the supplies during the dry months, then the surplus collected in reservoirs would be sufficient to meet the wants of your town.*

Another question, however, here suggests itself—namely, the right of the Town Commissioners to enter upon lands outside their borough boundary, and to deprive the farmers and mill-owners along the banks of Waterunder and Tullyescar streams, from Killineer to the Boyne, on the north-east and north-west of the town, comprising an extensive stretch of country, of their natural water supply. Assuming, however, that this power exists, the capability of the Commissioners' income to meet the multiplicity of claims for damages, that would be the result of taking all the water—for all appears necessary—is questionable. At one time I was under the impression—from data furnished to me by one of my assistants during the Relief Works in 1847—that the supplies from the sources referred to would have been sufficient for all purposes, except those of mill-owners; but the observations I have taken myself, checked by those of an assistant, places this fact beyond question, that from February to August the united supplies do not exceed from one-third to one-half of the minimum supply of 34 cubic feet per minute. These sources, have, however, a very strong recommendation, which is that water from them could be made available so as to command, naturally, the highest portions of the town. The proposed distributing reservoir of Hardman's garden could be supplied from the natural fall of the ground, with a pipe of small diameter. If a higher head were required to furnish the upper rooms of the houses in the highest parts of the town, or to extinguish fires there, a reservoir on, or near the site of Mr. Harpur's pond, or higher up, could be made available; but a reservoir in Moneymore would have this striking disadvantage, that without any material increase to the supply—not included in the foregoing estimates—there would be a loss of head of about 25 feet, which would command the third floor in an ordinary sized house, and it would be most exposed to the encroachments of cattle. All the sources here described may, however, be made available to the extent I have pointed out, their great and only disadvantage being the present apparent insufficiency of their supply.

The next sources which present themselves, are the Boyne and its tributaries, to the west of Drogheda. It is evident that one of the primary considerations with the commissioners must be expense; for however valuable it may be to fix on a pure and abundant supply, the cost of delivery at a given elevation in Drogheda, pure as at the source and ready for distribution, must be the guiding consideration. Now, all open channels for water supply are objectionable; for, as the quantity following, is in general small, it is more easily affected by light, heat, and atmospheric causes than when flowing in a large body, besides, an open channel is subject to impurities, arising from imperfect construction—banks falling in, vegetation, pro-creation of animalculæ, frost, and being open at all times to the inroads of man and beast—the quality of the water must be deteriorated, and its regular supply occasionally cut off, unless the channel be much larger than would be otherwise necessary, and deeper than

* On this date the water immediately below Waterunder-bridge entirely disappeared, passing through the bed into some underground channel.

† According to gaugings made on the 7th August since this report was furnished, the quantity flowing in the Waterunder stream was 42 cubic feet, and from the Tullyescar stream 35 cubic feet per minute, making together 77 cubic feet, or more than double the necessary supply; this was after heavy rains on the preceding days.

* It has been since determined that a sufficient quantity could be collected from Tullyescar, subject to a charge for collateral damages to the mill-owners and farmers below.

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frost can penetrate. But a closed channel involves increased expenditure in its construction, and hence, the great necessity for shortening by every means the length of the supplying channel. This consideration, and your limited resources, causes me at once to reject the idea of seeking for a supply from the waters of the Boyne, so high up as Slane or Navan, or at any considerable distance from the town. To dam up the Boyne lower down, or to raise the level of its waters in any way so as to shut out the tidal waters and gain head—unless as shall be hereafter described—is equally objectionable, and doing so, would affect the mills and lands above, and involve serious questions of damages which it is desirable to avoid—at least beyond your borough boundary, or its near vicinity. One plan only then remains, which is to take the water from the Boyne, immediately above the Weir at Oldbridge, at the head of the canal. This weir is sufficiently high to shut out the tidal waters unless occasionally during high springs and easterly winds, when the supply could be cut off and taken from an overplus to be continually maintained in the town-distributing reservoirs. To bring the water by a closed channel to the low ground underneath Ball's grove, and to raise it by means of a Cornish engine, to distributing reservoirs—one at Ball's grove, and the other at Hardman's garden—from whence to supply the southern and northern sides of the town. The water in these reservoirs would be nearly at the same level, which would enable you to dispense with, and save the cost of a stand pipe for the engine; a second engine being kept that could be worked when the first required repairs.

The next consideration in this project is the manner and cost of raising the water from the proposed receiving reservoir beneath Ball's grove. This will depend on the quantity to be raised, and on the height to which it is proposed to raise it. The situations in immediate connexion with Drogheda which are best suited for distributing reservoirs are those near Hardman's garden, and those at Ball's grove: the former being 114 feet over the level of the trackway along the Boyne, and the latter 103 feet; but as it is necessary to provide for the greater altitude, I will assume the higher of these *i.e.*, 114 feet. There will be a loss from friction of about 6 feet, and the receiving reservoir may be taken at about 10 feet below the trackway; and, hence, both these added to the former height of 114 feet will give 130 feet for the height to which the water has to be raised. I will assume also that it is necessary to raise 75 cubic feet per minute, or the whole quantity which the proposed channel from Oldbridge can furnish, and which would be very nearly 34 gallons per diem to each inhabitant. The net horse power required for this purpose would be represented by 18½—taking a horse power at the usual standard of 33,000 lb. raised 1 foot high in one minute—but I have to add one-sixth to this for loss on Sundays, and making for other losses an allowance of about 15 per cent., we get 24-horse power for that required in the engine, and for which a duplicate is necessary to continue the working when the first gets out of order.

The power of the engine is, however, of secondary importance in an economical point of view compared with its duty or its capability of raising a given quantity of water by the consumption of a given quantity of coals; for the first cost is in some engines of minor consideration compared with their saving or waste of fuel. Under all the circumstances, a steam engine, on the principle of the Cornish engine, is what is best suited for the purpose. This can be constructed equal to a duty of at least 70,000,000 lb. viz. This weight of water raised 1 foot high with the consumption of one bushel weighing 94 lbs. of Newcastle coals. This engine would require 192 tons of coals annually working 24 hours per day, and raising 75 cubic feet per minute; but working only 12 hours it would require more than half of this quantity. We may, therefore, take the maximum consumption of coals required at 200 tons annually; which is capable of furnishing each inhabitant at a height of 130 feet with 34 gallons per diem. This is equal to an average daily consumption of 11 cwt. of coals, and a daily consumption of about 6 cwt. will furnish a supply of 15 gallons per inhabitant, which would be equivalent to the power of the same engine working daily for only 12 hours. By freighting a vessel with coals, specially, the quantity required may be had direct at about 12*s.* per ton; but assuming the cost at 15*s.* per ton, we have from 80*l.* to 150*l.* per annum for the cost of coals according as the lesser or greater quantity of 15 or 34 gallons per head is raised to the distributing cisterns. It will be perceived by persons conversant with calculations such as the foregoing that I have not been very minute in giving results, for wishing to make them generally intelligible, I have viewed them in a plain and practical manner, avoiding small quantities and everything but a broad accuracy, yet so as to insure a fair estimate. The other items of cost, including engineman, stoker, &c., will be embodied in the concluding estimates, and will amount to about 200*l.* per annum.

One other plan for raising the water delivered under Ball's grove, may be referred to here as worthy of attention. It is to construct a weir across the Boyne somewhere between John's-gate and the borough boundary mark, so as to constantly maintain the level of the upper water up to that of the level of ordinary neap tide, and to make use of the fall to turn a turbine of the necessary power for pumping up the water supply as before described. This weir could be made available for a passage or roadway supported on upright frames for connecting the northern part of the town towards George's-street with the southern portion beneath Ball's grove; it would give a long sought for line of communication. The objections to this plan are, first a lock and moveable bridge would be required on the southern side to allow the passage of boats, secondly, the maintenance of a constant depth of water, equal to that at present in existence twice a day between the weir and the obelisk—but this could be of little damage to any one, and thirdly, the extra back water in winter and during floods. At these times, however, the lock gates could be kept open without injuring the water power, so as to pass off the upper waters more rapidly. The advantages of the weir would be, first, reducing the fall at the Oldbridge Lock during low water; secondly, the water above the weir could be made use of at low water to scour the bed of the river below it; and, thirdly, the facilities it would afford for the line of communication already referred to; but I am not prepared at present to enter into an estimate of this project. The commissioners will perceive that this plan is essentially different from that of constructing a weir near or above the obelisk, where the immediate consequences of back water would follow and exist at all times. In the plan now suggested, it is not proposed to raise the water at any time higher than what it now attains twice daily, viz., the ordinary mean height of neap tides. This weir would also have the advantage of shutting off the tidal waters more effectually from the source whence it is proposed to take the supply, and even to permit it to be taken twice a day from some point nearly opposite to Leonard's Cross, with a considerable saving in the length and cost of supply-pipes.

The next question for consideration is, the construction and cost of receiving and distributing reservoirs and their means of communication, and first it is to be observed, that as the proposed engines may have to work only 12 hours a day, the receiving reservoir must be sufficiently large to contain at least half the daily supply, unless that supply shall be shut off by proper sluices. A very small reservoir 100 feet by 100 feet by 5 feet will answer for this purpose, assuming the supply at 75 feet per minute, which it is to be recollected is more than double the minimum supply per day of 34 cubic feet referred to in the Tullyescar project. With such an inexhaustible supply as the Boyne is capable of furnishing, I do not consider it necessary to make the receiving reservoir exceed the capacity of one day's supply, but as it may be considered necessary at some time to construct filtering reservoirs, before pumping the water into the distributing reservoirs, it would be best to provide for them and the site of the engine and other works, by the purchase of say 4 statute acres somewhere under and in Ball's Grove. I propose using the land already purchased at Hardman's garden, as the site of the receiving reservoir which it is proposed shall contain, at least, 10 day's supply to furnish that portion of the town to the north of the Boyne. If any difficulty shall exist in purchasing a suitable site for another reservoir on the south side, the northern reservoir can be caused to supply the town at the south side of the river also, or *vice versâ*. The most convenient site for a reservoir on the south side, would be somewhere on the ridge of high ground over Ball's grove, which would give a head of 103 feet over the trackway along the Boyne. On examining the late census report, I found that the number of inhabitants on the north side of the Boyne is to the number on the south side as 2½ to 1 nearly, and this would of course give the relative proportion of the contents of the two reservoirs. I propose dividing the reservoirs into two portions to admit of cleaning each separately without interfering with the supply or distribution, and to make such primary preparations as would enable the commissioners to cover them in, at any after time, without

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again opening up the substructure. The whole quantity of land required on the south side of the Boyne for all purposes, including that required for filtering reservoirs, will not exceed 4 acres statute measure.

One of the disadvantages which arise from having to raise a water supply to a distributing reservoir, is, that a loss of power is incurred in supplying the lower houses; for the water has to be raised over them to the distributing reservoir or cistern, and a loss of power is incurred, so far equal to their difference of levels, and hence, if different reservoirs could be sufficiently arranged at different levels, each capable of supplying the district immediately below itself, a saving of power in the engines would be effected. Another consideration would be that of directly pumping the supply in some instances to the consumers, instead of raising it to the reservoirs and then returning it back to a lower level. These are matters, however, of detail which it is not necessary to dwell upon in this report, further than as an indication that they have not been forgotten.

The supply to the distributing reservoirs terminates the first portion of the question to be considered, and there is little to add further than the probable general estimates. The distribution itself is a separate element common to both projects; the cost of which must be directly proportionate to the cost of mains, and to the number of fountains and houses to be supplied separately. It being proposed to place fountains for the poorer inhabitants in suitable localities where the cost of separate house supply may be considered a too heavy expense.

The wells and springs which already supply the town should not be altogether neglected,* these are at best but a local convenience; and if of public use, the supplies are much too limited to be included in the question of water supply; as auxiliaries they will always be of use, more particularly, if economical reasons should induce the commissioners to fix on the deficient supply which can be obtained from the vicinity of Tullyescar, and the country to the north of the town, and dispense with collecting reservoirs for the present.

The cost of the proposed works, for collecting and supplying to a reservoir at Hardman's garden any quantity of water required would be under 10,000*l.*, including the collecting, supply, and filtering reservoirs, but not including collateral damages to mill-owners and farmers. The first cost of furnishing 75 cubic feet per minute from the Boyne, above the Oldbridge weir, including two engines, engine house, reservoirs at Ball's grove, and 1500*l.* for a pipe to supply the reservoir at Hardman's garden, would be 16,500*l.*, including land, and all collateral damages. This project would require also, an extra expenditure of about 350*l.* per annum, for coals, oil, hemp, repairs, engineman, and stoker. If the water be taken from the canal, above the lock at Oldbridge, a saving of about 3300*l.* would be effected in pipes, &c., reducing the outlay, to about 13,200*l.*, and leaving a sum of 3300*l.* which could otherwise be made available for filtering and distributing purposes.

The whole annual cost of filtering, including interest on capital at 5 per cent., will be about 75*l.* per annum. The first cost of filtering resources is, however, included in the general estimate, so as to reduce this sum to about 40*l.* per annum.

The cost of distribution now claims some attention. The distribution can be effected from time to time, so as to meet the wants of the public, and of individuals, in the most economical manner, at first, by the construction of about 14 fountains in the most convenient positions, 4 on the south and 10 on the north side of the river, and afterwards, by a supply to the houses of the better classes, public buildings, and manufactories, separately.† The mains to be abundantly large to meet the full distribution required for the town at any future time.

The actual cost of all works for house service, varies very much in different towns, and with the quantities supplied from a general average of 1*d.* per house, per week, to 2*d.*, and from an annual rate of 9*d.* in the pound to 1*s.* 6*d.*, and higher.

Now assume 4000 houses in Drogheda, these at 2*d.* each per week, would average over 1700*l.* per year, which capitalised amounts to 34,000*l.* The estimate to supply only 33 gallons per head is only 16,500*l.* at the outside, or 825*l.* per annum, leaving a balance of 875*l.* to meet the cost of distribution. If from this we deduct 350*l.*, the annual cost of pumping, 525*l.* per annum remains to meet the expenses of distribution, without any allowance for the sale of separate house supply. Now, four miles of mains will more than supply the proposed fountains for public use at the cost of about 5500*l.*, which is equal to a sum of 275*l.* per annum. This would leave a balance of 245*l.* per annum to meet a further distribution before the expenditure would be equal to a charge of 2*d.* per week per house. The sale of water for house supply is a legitimate source of income which it is not necessary for me to dwell on. The poorer classes will have for the present an abundant and convenient supply from the proposed fountains, the richer inhabitants should pay for it, delivered in their houses. In this view of the question an expenditure of 22,000*l.* will furnish and distribute from the Boyne at Oldbridge, 33 gallons of water per inhabitant per day through the town, with a head of 130 feet. While the Tullyescar springs will furnish a supply of only 5½ or 6 gallons per person per diem during the dry months, to be increased to an average of 15 gallons, by means of collecting reservoirs at an expense of 15,500*l.* It is almost unnecessary for me to add, that the distributive waterworks for private supply, should be carried on in connection with a general plan of drainage or sewerage for the town. The want of such a connection has been often complained of, and at New York, furnished with an ample supply of pure water from the Croton aqueduct, the salubrity of the city has been injured from want of properly designed drainage to carry off the extra supply, which, in many instances is left to escape by evaporation after saturating the premises where it had been delivered.

The analysis of the different waters has been received from Prof. Sullivan, of Dublin. He reports that the water of the Mattock river appears to be the purest, so far as the nature and the amount of the foreign substances held dissolved in it is concerned. The water of the Boyne comes next in quality to that of the Mattock river, the pump water being in every sense the worst, so far as amount of ingredients can be taken as a test of the quality of a water.

Table, showing the number of grains of organic matter, and the number of grains of solid matter in an imperial gallon of

Water from	Grains of Organic Matter per Imperial Gallon.	Grains of Solid Matter, per Imperial Gallon.	Hardness, according to the Soap Test.
Tullyescar	8·975 grains	31,175	15 $\frac{8}{10}$ °
River Mattock	2· (about)	15,360	9 $\frac{1}{10}$ °
River Boyne	3·250	22,700	84 $\frac{1}{10}$ °
Burn's Pump	7·100	76,850	34 $\frac{4}{10}$ °

As a general rule I believe that the water of clear flowing rivers, even though it may contain a large amount of solid matter, and even of organic matter, will be found wholesomer than well water, especially in towns.

The relative commercial values of the respective waters according to the soap test stands as follows:—Mattock 9·1, Boyne 14·9, Tullyescar 15·8, Burns pump water 34·4.* The expense of supply would be in the inverse order, but a full supply could only be had from the Boyne and Mattock, and from Tullyescar by means of collecting reservoirs. It has been found that the passage of water through reservoirs and pipes, reduces the degree of hardness by about 3°; it is therefore probable, that the Boyne water would be delivered for consumption with a hardness of 12°, if not less.† Under the circumstances I do not consider this too high. The Hitchen, Zouch, Southampton, and Ottery supplies, provided under the Board of Health, are some degrees harder. In all the water impurities in suspension can be removed by subsidence and filtration.

In conclusion, I have only to regret the delay which has occurred in forwarding this report, and yet the mechanical advantages of getting a supply from the neighbourhood of Tullyescar, are so great, that I would willingly delay it, in order to see if the winter supply to be preserved in collecting reservoirs, would in any way compensate for the deficiency during summer. I am of opinion besides, that the excess of organic impurities in the Tullyescar specimen must have been owing to some temporary and local interference with that portion

* The water collected from these on the north or south side of the Boyne may be elevated by steam power, the same as the water from Oldbridge.

† It is hoped that the fountains may be entirely dispensed with, and that service-pipes for a constant supply, with the necessary cocks, &c., will be furnished to every house.

* The saving in soap effected by a reduction of 10° in hardness is found to be over 50 per cent.

† And considerably less, after boiling probably to about 2°.

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of the stream from which it was taken; though, not observed by me at the time.* As the question now stands, I see no alternative between a supply from the Boyne or the Mattock, but that of a deficient supply or very large collecting reservoirs. The estimates are very ample—they are for permanent work, and include all contingencies—contractor's profits and engineering fees. The cost of pipes alone is not a very heavy item, but reservoirs, protective and incidental works, and a margin to cover extra contingencies, are all included. It is probable a reduction could be made, particularly in the Tullyescar project, and by the omission of the Hardman's garden reservoir; but as the commissioners have no power to take land for reservoirs outside their boundary, unless at the discretion of the owners, I consider it best to retain this element in the present estimate.

JOHN NEVILLE, C.E.

Jocelyn-street, Dundalk,
August, 1855.

NOTES OF THE MONTH.

At a special general meeting of the Royal Institute of British Architects, the following gentlemen, on the recommendation of the Council, were appointed to be the Board for the examination of District Surveyors, for 1856, as directed by section 33 of the New Metropolitan Buildings Act: viz., the Vice-President, the honorary secretaries, and Messrs. C. Fowler, Godwin, Hesketh, Inman, Pennethorne, Pownall, and Sydney Smirke.

The Royal Society have presented the Copley Medal to M. Foucault, and the Royal Medals to Messrs. Hind and Westwood.

Mr. John Lewis has been elected President of the Old Water Colour Society, in place of Mr. Copley Fielding, deceased.

An oil painting, said to be the portrait of Sir C. Wren, was exhibited at a recent meeting of the Royal Institute of British Architects., by Mr. Foggo.

The Corn Exchange, Coventry, by Mr. James Murray, architect, is fast drawing to completion, and will form the best modern architectural feature in the place. The style is a mixture of Italian and Lombardic. The work is solidly executed, and does great credit to Mr. Thomas Pratt, the contractor. The repairs and re-seating of Trinity Church are also in progress, under the superintendence of Mr. G. G. Scott, of Spring-gardens. Nothing else of importance is doing in the ancient city. Coventry was always considered one of the ugliest and most spiritless manufacturing towns in England, and it continues to bear out its character to this day.

A new Music Hall is building in Broad-street, Birmingham. The arrangements seem to be good and suitable for the purpose intended. Style, Gothic; Mr. J. Cranston, architect.

The Corn Exchange, Birmingham, built some time since by Mr. S. Hemming, architect, has lately been enlarged under the same architect. Part of the building stands on the tunnel of the Great Western Railway, which goes under the town. The difficulties are got over very satisfactorily to Mr. Brunel.

Two extensive carpet factories are in course of erection at Kidderminster. They promise to be the most convenient for light and machinery in the kingdom. Mr. J. G. Bland, of Birmingham, is the architect.

A communication on the question of slag bricks has been made to the *Society of Arts Journal* by Mr. Hyde Clarke. He says:—In the South Wales districts the copper works supply slag-bricks and coping-stones to some extent, the smelters receiving a small fee for moulding. Some of the slag-bricks are used even in the copper works. This is the case likewise in the works of the Mexican and South American Smelting Company, at Herradura, Caldera, and Tongoy, in Chili, where the walls of the ore-yards, and even the ash-pits and foundations of some of the furnaces are made of these materials. Rough slag is turned to account in making embankments near some of the Welsh and Lancashire Works, but is very porous. The moles at Herradura and Caldera are filled in with rough slag, and parts of the Tongoy and Herradura works are built on what was lately shore, but now land reclaimed from the Pacific by being covered with slag. One objection to slag bricks, which are otherwise cheap, is their brittleness.

* The sources being from the Silurian rocks, I am very strongly persuaded that the average hardness of the Tullyescar streams will not exceed 8° or 9°.

The New Victoria Docks, which have been excavated and formed on the western division of Plaistow Marshes, near Blackwall, and which are the largest of our metropolitan docks for expanse of water, were opened for the reception of shipping on Nov. 26. The entrance locks are of enormous proportions; they are upwards of 325 feet long, and 80 in width, with wrought-iron gates worked by hydraulic power, the depth of water at the entrance being 28 feet at high water—4 feet more than the East India Docks, 3 feet above the London Docks, 5 feet above the West India Docks, and 12 feet above the Grand Surrey Docks. The water area of the first dock is very nearly 100 acres, while on the south side there is nearly a mile of water frontage. There is a tidal basin, accessible by night as well as by day, for mail steamers and other vessels requiring despatch. The basin occupies sixteen acres, and varies in depth from 27 ft. 6 in. to 24 feet; that of the main basin is 28 feet. There are four substantial warehouses for the storing of goods on the north side; as also vaults for wines and spirits. All the cranes, capstans, and sluices throughout the establishment are worked by hydraulic power. The city depôt of the company is at the Steel-yard, in Upper Thames-street, where large warehouses and stores are to be formed. It is in contemplation to extend the docks to the opposite side of Plaistow Marshes, with an entrance from the Galleons, the necessary powers by Act of Parliament being in the possession of the company.

A tower formed of cast iron, for the manufacture of shot, has just been erected in New York, by Mr. J. M'Cullough, a shot manufacturer, the designer and builder being Mr. Jas. Bogardus, who is called the first projector of iron houses. The foundation of the tower is of solid masonry, 4½ feet thick, on a basis 18 feet below the surface of the ground, and 25 feet diameter; on this is bolted the first portion of the iron structure, through twenty holes 18 inches apart, by wrought-iron bars 2 inches diameter, to which the lower tier of cast-iron pillars are keyed. This tier of cast-iron columns supports the entire superstructure, and they are said to be of sufficient strength to sustain a weight of 28,000 tons. Upon the tops of the first tier of these columns there rests a cornice, made in ten sections, each pair meeting over the centre of a column. Upon the lines of junction stand the next tier of columns, then another cornice, succeeded by more columns, all made to break joint, and firmly bolted together. These are carried up to the height of 174 feet above the ground. The tower tapers from 25 feet outside diameter to 15½ feet, the inner compartment being 2 feet less. The metal employed in the construction is something under 100 tons, less than 170th part of what the first tier of columns would sustain. Mr. M'Cullough estimates that this tower is capable of making 5000 tons of shot per annum.

APPOINTMENTS.

The borough of Halifax advertises for a surveyor, to devote the whole of his time to the duties of the office; applications to be forwarded on or before the 1st of January.

Commander William Barrie has been appointed assistant to the Hydrographical Department of the Admiralty, in room of Lieutenant Francis G. Simkinson, appointed to the Meteorological Department of the Board of Trade.

OBITUARY.

27th November. John William Griffith, of St. John's-square, architect.

12th December. Arthur John Green, of 17, St. Helen's-place, London, architect, aged 35; he was suddenly seized with hemorrhage of the lungs, when at a small dinner-party, and expired instantly. The deceased filled the office of honorary secretary of the Wykeham Society; architect to the East India Company, and surveyor to the Globe Insurance Company. He was elected a Fellow of the Royal Institute of British Architects as recently as the 3rd ult.

20th December at Denbies, Dorking, Thomas Cubitt, the eminent builder, aged 68.

Lately, aged 71, Francis Rude, the French sculptor. His statue of the Neapolitan fishermen first made him famous, having for it received the cross of the Legion of Honour from Louis Philippe. He was the principal artist employed by M. Thiers in decorating the Arc de Triomphe de l'Etoile. The grand jury of the Paris Exhibition had, shortly before his death, awarded to him a grand medaille d'honneur.

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INSTITUTION OF CIVIL ENGINEERS.

Nov. 27, 1855.—JAMES SIMPSON, Esq., President, in the Chair.

The Paper read was "*On the Application of Volute-springs to the Safety-Valves of Locomotive and other Boilers.*" By J. BAILLIE; communicated by R. STEPHENSON, M.P., V.P.

The Volute Spring, stated to have been invented by Mr. Baillie, the Locomotive Superintendent of the Central Hungarian Railway, was described to consist of a single plate of steel, wound spirally in a conical shape, sustaining pressure and deflection in reference to its breadth instead of thickness, and was constructed of thicker and deeper plates according to the increased strength desired. The effect attained by this form of applying steel to resist pressure was found to be such, that equal loads were sustained by one-third the weight necessary for elliptical springs of like capabilities and power. From the peculiar mode in which the rigidity and elasticity of the material was applied in these springs, although so very light, they were not liable to break, or to be injured by any amount of force, if properly fitted; and the experience of upwards of seven years had proved that they were very economical for all railway purposes. The same experience had proved the unfitness of caoutchouc, or other substitutes for steel, for mechanical application, where great wear and tear had to be sustained, whilst the elliptical form of spring had many disadvantages, which were obviated by the direct action, the compactness, and the elasticity of the volute; and the saving effected by their adoption was not only in the first cost, which was great, but also in repairs, owing to the simple construciton and application of the volute; whilst, in addition, much of the iron-work necessary in fitting ordinary springs was saved.

It was stated that the volutes had been adapted not only to an immense number of locomotive engines, both abroad and in England, but also to tenders, wagons, trucks, and carriages for bearing, buffer, and traction springs, and in all cases with decided advantage, as to space and durability, over the ordinary elliptical springs. They were also now beginning to be employed as auxiliary springs for common road carts and wagons; and they were proved to be very valuable for many kinds of machines liable to sudden pressure, such as any unyielding substance passing between rollers, which would otherwise almost inevitably be fractured.

Concurring in the almost universal opinion, of the inadequate dimensions of the safety-valves being the most fruitful cause of explosions, and at the same time appreciating the practical difficulties attendant upon increasing the number or the area of the ordinary valves, with the present system of weighting them, Mr. Baillie determined to try whether a safety-valve of large area could not be conveniently and steadily held down by a number of volute-springs of known power; this appeared to act extremely well, and in order to test the new system, in comparison with the ordinary method, a safety-valve of 12 inches diameter, held down by seven volute-springs, was adapted to a locomotive boiler on which there was also an ordinary valve of 3·6 inches diameter, weighted with the usual lever and spring balance. The boiler possessed an area of heating surface of 890 square feet; but lest the cylinders should take too much steam, the engine remained stationary during the experiments, and the fire was urged by a constant jet of steam, of ½-inch diameter, into the chimney. The two valves were equally weighted to a pressure of 64 lb. per square inch. The large valve was then fastened down, and in four minutes the pressure of the steam had increased to 105 lb. when the small valve had risen $\frac{1}{12}$-inch, and the experiment was stopped, as the valve could not discharge the steam so ast as it was generated.

The small valve was then screwed down, and the large valve was set free; in four minutes the pressure had only increased from 64 lb. to 76lb. per square inch, or 12 lb., when the valve rose $\frac{1}{24}$-inch; and although the fire was powerfully urged for upwards of half an hour, the pressure of the steam could not be raised beyond 76 lb., as the large area of the safety-valve allowed all the steam that was generated to escape freely.

These experiments were considered so satisfactory, that the system of using volute springs for the valves had been generally adopted for the boilers of the locomotives of the Hungarian and Austrian railways, upon which Mr. Baillie was engaged.

In order to commence the discussion, a "*Description of an Improved Form of Safety Valve for Steam Boilers,*" by J. FENTON, M. Inst. C.E., was read by the Secretary.

The object of this valve was the prevention of accidents, arising from the liability of the ordinary mushroom-shaped safety-valves to stick fast; this was effected by making the valve spherical, with a hemispherical seat and a hemispherical cup bearing upon the ball valve; this cup was connected to the valve lever by a spherical joint; all the other joints of the lever and attachments being also on the ball and socket construction, so that all were free to move in any direction, and no sticking of any part was possible. A model of the single valve, and diagrams of both single and double valves, were exhibited; the latter were so arranged with a single lever as to act as a lock-up valve and an open valve combined, both being equally limited to the maximum pressure of the lock-up spring. A considerable number of these valves had been in use for some time, with decided success; they afforded a considerably greater security than the ordinary safety-valves, without greater expense of construction, and it was anticipated that they would be more durable than the ordinary valves, and be quite as easily repaired and kept in order.

In a recent letter to Mr. Kirtley, it was stated by Mr. Baillie, that eighty-one engines on the Hungarian and Austrian lines were carried upon volute-springs, and it was intended to alter all the others as opportunity offered. Double springs had been generally used for the middle bearing, but it was not now considered necessary, as some engines with single springs appeared to be quite as steady, and not to receive greater shocks than the others. The great point to be attended to was, that the volutes should not be overloaded, nor be screwed down too tightly. A volute of steel 5¼ inches broad and $\frac{7}{32}$-inch thick should not be loaded with more than 20 cwt., nor one of 4¼ inches broad and $\frac{7}{32}$-inch thick with more than 15 cwt., and it would be still better if their loads were reduced to 18 cwt. and 13½ cwt. respectively.

Great attention should be paid to the due and proportionate loading of the springs under an engine, and the engine-driver should be strictly prohibited from altering the position of the nuts on the holding bolts of the springs, as besides injuring the volutes, an undue weight must be thrown upon the other axles, and damage would ensue to the machine as well as to the rails.

With the ordinary flat springs, it was difficult to ascertain exactly what pressure was put upon them by altering the screws; but with the volutes a certain law obtained, which rendered evident the absolute pressure to which they were subjected. Each spring was depressed a certain distance by a given weight—say, for instance, those of certain dimensions would be depressed ¼-inch by 6 cwt.; so that if the spring was originally 8¼ inches high when unloaded, it would under a weight of 18 cwt. have been reduced to 7¼ inches in height; then by trying and marking the trial weights upon the volutes, and regulating them accordingly, there could not be any error in computing the pressure upon them.

The weighbridge for ascertaining the exact weight upon each wheel had been generally adopted with good effect, and to prevent the enginemen from altering the weight upon the springs, some thin washers were placed between the cross-bar and the collar upon each holding-bolt, which precluded the possibility of tampering with it. The effect of this regulation had been, that the engine-springs rarely required to be meddled with, and very few fractures occurred, unless the railway was in a bad state.

The reason for employing such heavy engines, for the conveyance of passengers, was that there was only one train of that kind per day, and one mixed train of passengers and goods at night; the former weighing about 160 to 180 tons, and running at a speed of 30 miles an hour, and the mixed train weighing from 250 to 270 tons, travelling 24 miles per hour. The bulk of the traffic consisted of goods, of which from 60 to 70,000 tons were conveyed per month, along the railway from Szegedin and Szolnok to Vienna, a distance of 304 English miles, which length it was intended to extend to Weiskirchen, about 140 miles further to the south-east of Szegedin.

An illustration was given of the adaptation of the volute springs to hydraulic safety valves for equalising the pressure on watermains and obviating the injurious effects of the concussion caused by the oscillation of the column of water. This system, which had been introduced by Mr. Croker, for the Amsterdam Water Works, was easily adjusted to a head of 170 feet, representing a pressure of 39·2 lb. per square inch, or a total load of 1970 lb. on the valve; it had been in use for six months, and might be perfectly relied upon.

The arrangement was very simple, consisting merely of a vertical branch of 8 inches diameter springing from the horizontal main pipe of 6 inches diameter. On the top of the branch pipe was fixed a valve and seat of gun metal, so arranged, that upon the lugs were fixed the wrought iron bolts holding the cross-bar; between the underside of which, and the top of the valve, was placed a volute spring of about 2½ tons pressure. The exact pressure was regulated by adjusting bolts provided with stop-nuts, and the apparatus could be accommodated to the required head with great facility and precision.

Drawings were exhibited of the "Wien Raab" locomotive engine, constructed by Mr. John Haswell, Locomotive Superintendent of the Vienna and Raab Railway, and sent to the Exhibition of Industry at Paris, in 1855. The chief characteristics of this engine, which was intended principally for the goods traffic, were its having outside cylinders, inside framing, and eight wheels, all coupled. As the distance between the axles of the leading and the trailing wheels was 12 feet, it was necessary to have special arrangements for enabling this great length to pass curves of short radius. This was accomplished by allowing the bearings of the trailing axle and its coupling rods to have a lateral motion of 18 lines; and, in the trials upon the Sommering inclines, of 1 in 40, it was found that this engine would draw up a load of about 110 tons, at an average speed of nearly 12 miles per hour, passing with facility round curves of as small a radius as 600 feet, the motion of the engine being much steadier than that of any others of the same power. When evaporating 200 cubic feet of water per hour, the engine could draw, on a level, a load of 1047 tons, at a speed of about 14½ miles per hour.

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The engine, with the water in the boiler, weighed 34 tons; and the division was so arranged, that no wheel pressed with more than 4·4 tons weight upon the rails,—a great superiority over other engines tried upon the line, as in some cases the weight was as much as seven tons upon one wheel, which would suffice to destroy the heaviest rails; and the ultimate effect was, that when the permanent way became uneven, the jerks were so severe, that the springs could not prevent them being seriously felt by the engine, the structure of which was soon dislocated.

The fire-box was arranged for burning wood or turf; but, with a trifling modification, could be adapted for coal or coke, and the spark-catcher was like that of the American engines.

All the chief working parts were so placed as to be fully in sight, and were easily accessible for examination, for oiling, and for repair. This desirable end was attained by employing the space within the frames, formerly; and, in other engines, occupied by the pumps and slides. The frames were firmly connected together by strong transverse stays, offering great resistance to lateral strain, and at the same time rendering the frame much stronger, with less weight of material; whilst the opposite axle-boxes were as firmly connected together as if they were formed out of one piece of metal.

The guides for preventing the lateral oscillation of the wheels and axles were placed in the centre between the axle-boxes; and between the side-plates was a guide-block, working upon a pin, on the same level as the axle traversing the guides. By this arrangement it became possible for one wheel to rise or fall, without the frame of the engine being strained.

The volute springs which were used for bearing the weight of the engine, were placed withinside the frame, and in consequence of the arrangements already described, could be fixed considerably lower than the ordinary flat springs,—thus obtaining the great advantage of lowering the centre of gravity.

The centre guard was omitted for the hinder, or sliding axle; and, in order that the springs might not interfere with the requisite lateral motion, the lower ends of the bolts, by whose upper ends the engine was suspended upon the springs, were allowed to turn with the play of the axle.

The wheels were cast-iron discs, with cast-steel tyres.

The boiler was of the ordinary construction, and had adapted to it a safety-valve with a large aperture, held down by the volute springs, by which any accumulation of pressure of steam beyond $\frac{9}{10}$ of an atmosphere above the maximum working pressure, was effectually prevented. In practice this had been found to offer an effectual protection against accidents arising from carelessness or daring, and the system was now adopted for all the engines on the railway.

Dec. 4, 1855.—JAMES SIMPSON, Esq., President, in the Chair.

The Paper read was "*On the Vertical Structure of the Primary Rocks, and the General Character of their Gold-bearing Varieties.*" By EVAN HOPKINS.

The author commenced by stating, that it was almost impossible to form a correct idea of the true character and geological position of the gold-bearing rocks, without being first acquainted with the symmetrical order of the crystalline structure of the fundamental series; hence the cause why the two subjects were combined in the paper.

The primary laminated rocks, the gneiss, micaceous schists, &c., usually represented in geological sections as layers, or stratified beds, were shown, by numerous illustrations and observations made in different parts of the world, to be always found, more or less, on edge, presenting a symmetrical structure very different to the sedimentary beds. In taking a comprehensive view of this structural phenomenon in the two hemispheres, the bearing of the vertical cleavage planes was described to approximate very closely to the direction of the true meridian, from the southern zone to the Arctic regions. This important fact the author asserted, from observations made by himself and others, from Terra del Fuego to California, and from Australia to the Ural Mountains. Reference was made to the geological sections of the different regions. Besides the symmetrical order of the structure, it appeared that the divisional, or cleavage planes of the primary series, presented a much finer crystalline grain and aspect than the divisional planes of the sedimentary rocks. It was shown that the character of the vertical schist depended on the nature of the granite base below; as, for instance, micaceous granite produced micaceous gneiss, micaceous schists, &c., by a gradual change, and, as it were, by an upward elongation of the component ingredients. The same with the other compounds, such as the hornblendic and chloritic granites.

It was generally supposed that the direction of the cleavage planes of the primary series depended on the direction of the chains of mountains; but the author contended that this idea could not be maintained, inasmuch as the vertical structure passed frequently across the ranges, such as the Veraguas, those of Victoria, and other countries; thus proving, that it must be the effect of a crystalline power, independent of the influence of the bearing of the chains of mountains.

This primary meridional structure had a great tendency to produce ridges in the direction of its bearing; therefore the predominance of north and south chains of mountains, like the South American, the Californian, and the Ural, must be considered rather the effect than the cause of the internal, vertical, and polar structure. Again, it was shown, that by means of the internal natural process, going on in the primary series, and acting in the direction of the divisional polar planes, that these rocks were not only continually changing their physical aspect, but likewise altering and obliterating the divisions of the superincumbent sedimentary beds, and frequently superinduced in them a corresponding vertical cleavage, and thus producing bands of roofing slate, at different angles to the planes of bedding, in conformity with the structure below.

The author expressed his conviction, that the propagation of erroneous views, such as those of the sedimentary origin of the primary slates and their being subsequently lifted to high angles, tended to vitiate the foundation of geological science as now taught, and that it was in the interest of true science, that any actual observations leading to more correct views, should be fairly and calmly discussed.

Purely scientific geologists generally, at present, directed their attention, chiefly, if not exclusively, to palæontology; considering, probably, that the study of the structure and the composition of rocks, mineralogy, the metalliferous formation, slate-quarries, &c., were subjects connected more immediately with the professional avocations of the mining engineer, than with the studies of scientific geologists.

These important branches of the geological science must however be attended to, studied, and represented as they were actually observed, and not by mere assumptions, if it was intended to render the science available for practical purposes to mining engineers.

The questions in connection with the metalliferous deposits, might, therefore, with propriety and advantage, be discussed by the members of the Institution, and thus they would assist in bringing geological science more effectively to bear, than it did at present, on mining and other underground operations.

The rocks which produced gold, and from which so large a quantity of that metal had lately been obtained, merely by digging and washing, belonged, it was stated, entirely to the primary series, and not to the fossiliferous or sedimentary beds, as had been sometimes assumed. It appeared, that the less the vertical edges of the primary slates were covered by compact sedimentary rocks, the more favourable were the conditions of the superficial actions for decomposing and liberating their metallic contents. Gold was never detected in the sedimentary rocks excepting in combination with quartz or pyrites, and then only in the vicinity of the primary series, and consequently derived therefrom. It was asserted, and shown in a section exhibited by the author, that it was by the superficial disintegration and final decomposition of a certain variety of the meridional crystalline bands that the gold deposits of South America, Veraguas, California, Australia, Africa, India, and the Ural, were produced; and the same description of structure and composition served for all the auriferous regions.

The more uniform the vertical and polar structure appeared to be, the more prolific the primary series was found in gold, and *vice versa*, in all the regions yet explored. It was possible, on a cursory examination of the structure and composition of the primary rocks, to determine what metals or minerals they would produce, and also whether such products would be found disseminated throughout the bands of rocks, or be aggregated into masses.

The author described an interesting natural process, sometimes detected in the auriferous granite, where these rocks decomposed towards the surface into an aggregation of round balls. It was stated, that during this change, an efflorescence of black ferruginous mineral with gold, became formed in the divisions of the concentric foliating coatings of the balls, which by disintegration liberated the precious metal.

Again, by the aid of surface moisture, and the absorbing action of the roots of large trees, growing on the edges of gold-bearing rocks, these rocks become gradually disintegrated and decomposed, the protoxide of iron being converted into the friable peroxide, and the alkali of the felspar was taken up by the roots, leaving the metal behind, precipated and aggregated into masses. Some of the gold nuggets of Australia and Chili had been found under such circumstances. These metallic productions were confined to no fixed period; on the contrary, the process appeared to be incessant, and only varying in its amount and intensity, according to local circumstances.

In order to predict, with any degree of accuracy, the existence of gold in any given region, in quantities worthy of commercial consideration, the author stated, that it was indispensable to ascertain the following particulars:—

1st.—If the primary series was uncovered by sedimentary rocks and subject to disintegration; &c.

2nd.—If the structure was found in a vertical and, more or less, in a polar direction.

3rd.—If the meridional crystalline bands predominated in ferruginous argillaceous schists, with talcose and quartzose slate, as described in the sections.

Without ascertaining these particulars, the author declared it would be impossible for any person to predict, correctly, the existence of gold in large quantities in any region.

It was stated, that the gold quartz veins enclosed in the primary slate,

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were but sparingly impregnated with gold, and that principally in the portion near the surface, and in fractures. These quartz veins, it appeared, were rarely, if ever, found to be sufficiently productive to pay for working to a depth of many fathoms below the surface, unless the quartz was friable and strongly impregnated with iron pyrites. The reason of the common supposition, of quartz being the matrix producing the gold, was, that the gold attached to it adhered more strongly to quartz than to any other of the gold-producing rocks. What were called deep sinkings at the gold diggings, must not be considered as sinking into the hard rock like ordinary mining, but merely sinking through the consolidated soil and debris, down to the edges of the primary rocks. It appeared, according to the author's description, and the sections exhibited, that the workings prosecuted in the out-crop of auriferous quartz, were very superficial, and scattered in all directions,—only fit for hard-working parties, and not eligible sites for the speculations of public companies.

The terms "drift" and "alluvial" were often misapplied. It was commonly stated that the gold was found in the "drift," &c., of the colony of Victoria; meaning thereby, that the gold was brought to the deposits from a distance, whereas the largest portion of the auriferous deposits of the colony of Victoria, according to the author's views, were found *in situ*, on the edges of the bands of rocks producing the gold.

It was commonly imagined that the diggers were obtaining great riches, and, therefore, that public companies ought to make great profits. Now, according to the author, this idea was founded in misconception. The diggers, on an average, barely obtained an amount of gold equal in value, to 2*l*. per man per week; whereas the companies paid upwards of 3*l*. per week for similar labour; this fact, coupled with that of the companies not being able to procure productive gold ground, would, to some extent, account for their ill success in the colonies.

The following statement was given, to show the value of gold obtained since 1851, chiefly by ordinary digging and washing, from two of the most productive gold regions in the world—California and the colony of Victoria.

California.

In 1851.	Value in round numbers	£6,898,500
1852	,, ,, ...	9,155,800
1853	,, ,, ...	10,781,400
1854	,, ,, ...	10,302,000
1855.	Estimated (on 9 months' produce) ...	8,644,000

The Colony of Victoria.

Part of 1851 & 1852.	Value in round numbers ...	£14,000,000
1853	,, ,, ...	11,500,000
1854	,, ,, ...	8,300,000
1855.	Estimated (on the produce of 9 months)	8,000,000

The author expected, that by granting more liberal terms to systematic companies of diggers, increasing the facilities for obtaining and accumulating water, adopting improved modes of washing, &c., the produce of gold from the colony of Victoria alone would not fall much below the value of 6,000,000*l*. per annum, for some years to come, which was about double the amount of gold now obtained from the Ural, or Siberian, gold-fields.

At the monthly ballot, the following candidates were balloted for and duly elected:—Messrs. J. J. Berkley, H. H. Edwards, and C. Jopp, as Members; J. Cochrane, F. R. Conder, R. R. Rowe, and W. B. Scott, as Associates.

Dec. 11.—In the discussion upon Mr. Evan Hopkins' Paper, it was objected, that the subject was one of so purely a geological character as to be scarcely adapted for a meeting of Civil Engineers; it was, however, contended, that as mining was an important part of the professional employment of engineers, and the regulations respecting the reception of subjects for the meetings, expressly included "Essays on Geology, &c.," the discussion of such questions clearly came within the province of the Society; and moreover, that it was desirable to introduce such subjects, inasmuch as engineers had been reproached for not having devoted more attention to the science of geology.

It was shown, that although the Paper had unavoidably commenced with an exposition of a theory of the structure of the primary rocks not in accordance with received opinions, but professing to be derived from personal investigation of extensive districts in various parts of the world, the actual question treated of was intimately connected with the practice of the mining engineer, whose professional avocations demanded constant observation of the bearing, direction, and metalliferous deposits of districts. The pure geologist might give the scientific features, but the practical treatment of the subject fell within the province of the mining engineer.

The statements in the Paper, and the sections exhibited, which were the result of personal observations, extending over a long period, were not purely ideal, like those well-known sections published in many standard geological works, wherein the metamorphic rocks were shown as protruding through the crust of the earth and assuming partially horizontal positions. It was contended, that the primary series did, in all the great ranges, exhibit a nearly vertical structure, in a radial direction from the axis of the globe, and that the sedimentary strata alone had horizontal, or concentric positions. Taking Australia as an example, it was impossible to find anything more regular than the course of the vertical bands, north and south, and preserving a uniform width; the practical diggers were fully aware of the fact, and in "prospecting" always followed these indications, with success. It was contended, that the gold found in the form of nuggets was derived by the process of aggregation, from the disintegration of the friable surface points of the primary rocks, and that they had not been brought from a distance by any drift, or movement of alluvial deposit.

It was opposed to these views, that this novel theory was contrary to the received opinions of eminent geologists, and was only supported by observations whose accuracy had not been confirmed by other travellers. The theory here propounded had been already discussed by geologists, and had been considered as untenable, and not consistent with the present state of knowledge. In the gold districts of the Brazils, of Hungary, the Tyrol, Virginia, or of North Carolina, there were no indications of this vertical position of the primary series, and neither in North Wales, in Scotland, nor in Cornwall, was it evident. The slate formations of Wales and Prussia were not referable to the causes stated in the Paper, and the deposits of stream tin in Cornwall and elsewhere were decidedly found in alluvial soil proceeding from other districts.

With respect to the statistics of the Gold production of Australia and California, it might rather be shown, that large numbers of the diggers had accumulated a certain amount of wealth, and tiring of so severe and adventurous a career, had resumed their former agricultural employments.

On the other hand it was contended, that the observations should be admitted to be conscientious, until they were demonstrated by other travellers to be erroneous. Now, without adopting the peculiar views of the author, it must be admitted, that in South America there were many and great deviations from the ordinary series of stratification, as taught by geologists, and each year, even in England, new facts were brought to light, which should have been discovered long ago, if the rules of geology had been so unalterably fixed and determined. It was a somewhat arbitrary solution, to refer all alterations of position to upheaving, without being able to account for the causes of those supposed convulsions. The author should certainly have credit for what he had observed, until it was shown that the observations were incorrect.

It was contended, that the cleavage to which the author had invited attention, was a well known phenomenon, which had been excellently described by Professor Sedgwick thirty years ago, but it must not be confounded with stratification, nor could there be attributed to it the uniformity of dip and direction asserted in the Paper; such a position would carry back the science of geology nearly half a century. It was not sought to impugn the intentions of the author of the Paper, but it was asserted that his observations were partial and defective.

It was contended by another observer, who had devoted much time to the investigation of the gold regions in various parts of the world, that though the primary rocks did appear to be inclined at a high angle, he had never seen them so symmetrically arranged, or so uniform as in the sections exhibited; but the same might be said of all the sections emanating from the most learned geologists.

As to the alleged failure of most of the attempts at remunerative mining in gold-bearing quartz, the reasons were sufficiently evident: inefficient persons had generally been sent out to direct the works, they never were vested with proper authority, and generally were restricted in means, besides which, the general body of diggers must be opposed to them, and they were thwarted on all occasions, and misinformed on all subjects, and by the time the, probably inappropriate, machinery sent from this country reached its destination, the funds of the company failed, either from the withdrawal of the confidence of the shareholders, or other equally fatal cause, and the company was dissolved. It was contended that the gold was deposited in drifted material, and was probably washed from other localities; if this were correct, it was necessary to consider the eventual necessity for working into the primary rocks, whence the gold proceeded, and devising the methods of arriving at their contents, by simple and comparatively economical means.

The questions of the apparent existence, or non-existence of gold in certain localities, had too often been rashly decided by persons sent from this country in utter ignorance of the peculiar features of the gold districts, although they might have been good geologists and experienced miners in other mineral fields. In corroboration of this position various specimens were exhibited; some of them evidently very rich in gold, and others exhibiting no visible traces of metal; it was, however, asserted, that by a treatment somewhat analogous to that designated by the old German alchymists, "a mode of compelling the gold to come to the surface," the same visible traces of gold would be obtained.

In reply to the latter part of this position it was stated, that probably the system alluded to, was what the miners called "sweating," which was merely subjecting the lumps of quartz, or other rock to considerable heat in a stove, when the gold generally became visible; that process was very ancient. The alchymists of old were very erudite men, and had left entertaining accounts of their studies, but it appeared singular, that almost invariably, just at the critical moment, the crucible cracked, or some other catastrophe occurred, so that no gold was ever found, and no elixir vitæ ever brewed.

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On the further examination of the specimens, it was declared, that one of them was entirely devoid of gold in any form; it was a piece of pure quartz with a little oxide of iron in it; if it had contained sulphate of iron, there might also have been some gold with it.

It was objected, that observations truly made in one locality might, if assumed to be equally applicable to all others, induce serious errors, and such was to be apprehended from a too-ready assumption of enticing theory. The actual difference between beds and cleavage and the intersecting porphyritic veins was exemplified by sketches of portions of the Coast of Cornwall, and of the slate formation in North Wales.

It was admitted that the author of the Paper had done good practical service to the mining engineers and to geologists, although he might, in carrying his views too far, almost have been guilty of heresy.

It was shown by quotations from the works of the late Sir Henry De la Beche, that he too had observed the same uniformity of range of the metamorphic rocks, and had attributed considerable influence to Polar Magnetic action. Still it was urged against the observations of the author, that if the theory raised upon them was pushed too far it might be injurious to real science.

In replying to the general remarks, it was urged, that the Paper had been written for the purpose of inviting discussion on the practical part of the subject, which was the peculiar features of the gold-bearing series of rocks, and these had been given honestly from personal observation. If these features were not in accordance with the views of geological science as now taught, a modification must be introduced, unless it could be found that the sections were not truthful. There was no reason why that part of geology, connected with mining, should not be subject to as much change in these days as during the last half century; experience in new and extensive districts, hitherto unexplored, showed how much there was still to learn, and that in these days careful observation was the one thing needed.

It had been asserted, that the primary rocks in the gold districts of Virginia, U. S. America, did not present a vertical character. Now, in the Reports of Messrs. Andres del Rio, and Mr. John Millington, they said of the rocks of that district, "They stood vertical in the talcoze state." Professor Silliman said of the same gold region, "The strata stand nearly vertical, and have a direction of about 10° east of north." Mr. J. D. Whitney, mining engineer, wrote of that extensive district, "The prevailing dip is to the east, at a very high angle. In Virginia they stand nearly vertical." Messrs. Clennon and Rogers stated, "The general strike (of talcoze slate rocks) is from 29° to 32° east of north. The laminæ stand vertical." The veteran geologist, Professor Sedgwick, whose authority had been invoked, made these apposite remarks: "In the Welsh slate rocks, we see the cleavage planes preserving an almost geometrical parallelism, while they pass through contorted strata of hard slate, obviously of sedimentary origin—crystalline forces have re-arranged whole mountain masses of them, producing a beautiful crystalline cleavage, passing alike through all the strata. And again, through all this region, whatever be the contortions of the rocks, the planes of cleavage pass on, generally without deviation, running in parallel lines from one end to the other. Without considering the crystalline flakes along the planes of cleavage, we may affirm that no retreat of parts, no contraction in dimensions, in passing to a solid state, can explain such phenomena as these. They appear to me only resolvable on the supposition that crystalline, or polar forces acted on the whole mass in given directions and with adequate power." Such were the admirable observations of Professor Sedgwick on the slaty cleavage, and it is much to be regretted that he did not follow up the subject.

Professor Blake thus described the gold regions of California. "The metamorphic rocks consist of micaceous schists and slates, both talcoze and micaceous,"—"it is rare to find a dip of less than 70°, and they are generally very nearly perpendicular. The strike of the beds is extremely uniform, being from 5° to 10° west of north and east of south. They are found in a belt of land from thirty to sixty miles broad, running parallel with the axis of the range, throughout all the gold-bearing region, for hundreds of miles from south to north."

Mr. James Wilson, in his Notes on the gold regions of California, said of the Sonora diggings: "The western border is composed of chlorite slate; and the eastern, of micaceous slate; the slates are vertical, and in a state of rapid decomposition."—"They all stand vertical and parallel with the mountain range."

Mr. Hargreaves, in the account of his adventures in California, giving the reasons why he expected to find gold on his return to New South Wales, said: "Without any knowledge of the science of geology, I simply compared, in my own mind, the geological formations, which I saw in California, with others that I had seen in Australia, and becoming fully persuaded that if the existence of gold was to be tested by such outward appearances, gold must exist in Australia as well as in California, I acted on that persuasion, and at the very first trial (on my return to New South Wales) discovered the existence of gold."

"My attention (whilst in California) was naturally drawn to the form and geological structure of the surrounding country, and it soon struck me that I had travelled through a country very similar in New South Wales: some laughed at me, and others forcibly objected, because many professed geologists had travelled over the country to which I referred, and said if it was auriferous they must necessarily have discovered it But I knew how different scientific knowledge was to practical experience. As regards the geological structure of the country (California), being no professed geologist, I can only give my observations in my own way. The digging ground was composed of vertical slates and quartz veins, which generally ran north and south. We worked for gold in the drift overlaying the slates, and also found gold in the laminæ of these rocks.

"Having all along confessed my ignorance of geology, as a science, it may be thought presumptuous in me to attempt to arraign the opinions of men who are acknowledged proficients in that science. But I believe that many professed students of that science are apt to adopt too readily the opinions of professed masters, without themselves investigating the proofs on which any particular conclusion has been arrived at."

In official reports of the Gold Commissioners of New South Wales, it was said, "Further westward, towards the gold-bearing rocks, the formation changes into a series of white quartz and mica slate, and then argillaceous, chloritic, and hornblendic slates, to Canoblas range; all vertical and in a north and south direction."

Mr. Wathen, mining engineer, in his paper on the gold-fields of Victoria, said, "This mountain chain, in Victoria, consists of clay-slates, mica-slates, and flinty-slates, in successive steps, forming collectively a recurring series. The slates are nearly, or quite vertical, with a north and south strike."—"It is in the valleys and gullies of these mountains that the rich deposits of gold are found."

Mr. W. Howitt stated, "these quartz ridges form portions of those singular ridges of rocks which run from north to south over the hills of the gold regions here." (Victoria).—"A great portion of these ridges consists of clay-slate, the strata being all perpendicular."—"It would seem as though some subterranean force, acting in this direction, had burst up the strata, in these long north and south lines and left them standing edgeways."—"They are always true to this one direction, and are nearly as good as a compass, and you may trace them for twenty, or thirty miles at a stretch, and no doubt they extend right across the colony."

It was contended that this corroborative evidence of the correctness of the observations in the Paper could not be lightly passed over, in a society composed of pre-eminently practical men, either because the propositions were not in accordance with accepted theories, or because those who dissented had not had any opportunity of making personal observations, to enable them either to confirm, or deny with authority the observations of the author. The Institution was therefore urged to act in this case on the same principles as it adopted in all others,—to submit everything to the test of practical proof, so as to distinguish facts, founded on personal experience and observation, from symmetrical systems based upon arbitrary assumption.

THE MECHANICAL INVENTIONS OF DR. HOOKE.

Mr. A. Bryson, at the annual general meeting of the Royal Scottish Society of Arts, delivered an exposition on the above. The instruments referred to being exhibited, he commenced by alluding to the small share of popular fame which had fallen to the lot of Hooke. Three circumstances had combined to produce this result—his proximity to Newton, his want of method, and the scarcity of his works. Mr. Bryson exhibited a variety of instruments invented by Hooke, and in daily use, to none of which, with one exception, that of Hooke's universal joint, had his name been conjoined. Among the principal inventions of Hooke might be enumerated, the air pump, the transit sextant, the double-tubed barometer, the wheel barometer, the marine barometer, now known as Adie's sympiesometer, the quadrant, the watch-wheel cutting engine, the stethoscope, the conical pendulum, the duplex escapement (which is now used as the best pocket timekeeper), and the balance spring for the watch, and the spring scales now known as Salter's improved weighing-machine.

NEW PATENTS.

PROVISIONAL PROTECTIONS GRANTED UNDER THE PATENT LAW AMENDMENT ACT.

Dated July 18.

1609. T. L. M. Riot, and S. G. P. Dehais, Paris—Improvements in the treatment of silk

Dated July 28.

1715. C. E. Paris, Paris—A new material to be used in the manufacture of crystal, enamel, and other similar products

Dated August 29.

1953. J. Hanson, Doagh, Belfast—Improvements in machinery or apparatus for digging or working land, and removing roots or plants therefrom

Dated September 6.

2019. J. Fraser, Jermyn-street—An improvement in the manufacture of paper. (Communication)

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Dated October 9.

2252. E. Rowland and J. Rowland, Manchester—Improvements in locomotive steam-engines

Dated October 12.

2279. J. Clark, Strand—Cooking apparatus for the pocket

Dated October 13.

2291. J. Dewrance, Barge-yard, Bucklersbury—An improvement in the frames of pianofortes

Dated October 19.

2342. W. Tatham, Rochdale, Lancaster—Improvements in machinery or apparatus for preparing, spinning, doubling, and winding cotton, wool, flax, silk, or other fibrous substances

Dated October 22.

2359. A. Parkes, Burry Port, Llanelly, Carmarthen—Preparations of oils for, and solutions used when water-proofing, and for the manufacture of various articles by the use of such compounds

2361. C. Lenny, Croydon—Improvements in carriages

Dated October 23.

2369. J. Bellamy, Lower-road, Islington—Improvements in graining and in producing imitative ornamental surfaces, and in certain instruments or apparatus to be employed for such purposes

Dated October 27.

2397. E. Stark, Monkton, Isle of Thanet—Improvements in pens for writing

2398. H. Wyatt, Pall-mall—A peculiar apparatus for more rapidly and perfectly manœuvring or steering steam ships of war or of commerce, which is entitled "The Transpulsor."

Dated October 29.

2409. T. A. Temperton, Manchester—Improvements in shells and rockets, and other projectiles of the like nature

2411. J. Kennard, Little Queen-street, Holborn—An improvement in the manufacture of childrens' and invalids' carriages

2413. G. J. P. M. Villeroux, Paris—Improvement in the manufacture of soap

2415. J. H. Johnson, Lincoln's-inn-fields—Improvements in regulating the transmission of motive power. (Communication from F. T. Moison, Mouy, France)

Dated October 30.

2417. P. E. Chappuis, Fleet-street and St. Mary-axe—Improvements in reflectors for the diffusion of artificial light

2419. W. Naylor, Norwich—Improvements in power hammers and rivetting machines

2421. T. Hocroft, Tividale, Stafford, and R. Forrest, Tipton—Improvements in the manufacture of iron rods, bars, hoops, merchant, and guide iron

Dated October 31.

2423. W. H. Walenn, Regent-street—Self-acting attachment to be applied to gates. (Communication from H. Davis, United States)

2425. J. G. Lawrie, Glasgow—Improvements in ship-building, to facillitate the use of water as ballast

2427. H. E. Drayson, Maresfield Powder Mills, Sussex—An improvement in the manufacture of gunpowder

2429. T. J. Swinburne, South Shields—Improvements in furnaces or apparatus used in the manufacture of glass

2431. R. P. Forlong, Bristol—An improved manufacture of manure

Dated November 1.

2433. J. Leetch, Margaret-street—An improved method of constructing apparatus for the covering of the head

2435. H. Laxton, Arundel-street, Strand—Improvements in gearing for increasing or decreasing rotary speed. (Communication)

2437. G. Milner, Hollen-street, Wardour-street, Middlesex—Improvements in the manufacture of bedstead bottoms, part of which improvements are applicable to various other purposes for commercial and domestic use

2439. W. Taylor, Haughton, near Shiffnal, Salop—An improvement or improvements in the manufacture of iron

2441. J. Bentham, Bradford—Improvements in looms for weaving

2443. R. Kerr, Glasgow—Improvements in spinning together fibrous materials of different kinds

2445. W. H. Walenn, Regent-street—Improvements in pianofortes. (Communication from S. B. Priggs, U.S.)

Dated November 2.

2447. I. Baggs, Pentonville and H. F. Osman, Essex-street—Improvements in steam-engines and in engines generally which are worked either by gas, air, or vapour, and in apparatus for generating electricity, for effecting parts of said improvements, and for other purposes

2449. M. Osborne, Birmingham — Improvements in metallic bedsteads and other articles of metallic furniture

2451. R. Cook, Glasgow—Improvements in apparatus for effecting the operations of punching, riveting, and shearing

2453. S. Heseltine, Harwich—Improvements in the means of ascertaining the depth of water in rivers, harbours, and at sea

2455. J. Jones, St. Asaph, Flint, North Wales—Improvements in electric telegraphs

Dated November 3.

2457. J. Heginbottom, Ovenden, Halifax — Improvements in furnaces and apparatus for generating steam, whereby the smoke will be consumed and the fuel economised

2459. J. Pattison, Glasgow—Improvements in machinery for dressing and finishing woven goods and fabrics

2461. T. R. Cooper, White Mill-cottage, Battersea-fields—Obtaining motion with power and velocity by purely mechanical means

2463. J. Binning, Liverpool—Improvements applicable to embossing presses

2465. T. R. Bridson, Bolton-le-Moors, Lancaster — Improvements in preparing, beetling or finishing textile fabrics

2467. W. P. Sharp and W. Weild, Manchester—Improvements in the reeling or winding of cocoons, and in the manufacture of silk threads, and in machinery and apparatus for these purposes. (Partly a communication)

2469. G. Lloyd, Birmingham—Improvement or improvements in illumination

2471. R. A. Brooman, Fleet-street—Improvements in knitting-machinery. (Communication)

Dated November 5.

2473. R. S. Garden, Piccadilly—Improvements in the manufacture of hats

2475. A. Dobson, Belfast—Improvements in preparing certain unbleached linen fabrics

2477. J. Nuttall, Silver-street, London—An improved gauntlet-glove and cuffed glove

2481. G. Burridge, Great Portland-street—Improvements in the preparation of glass for ornamental purposes

2483. G. B. Locke, Notting-hill—Apparatus, apparatuses, or mechanism, for placing detonating or fog-signals on the rails of railways to be exploded thereon, and for removing the same therefrom whenever required

2485. A. V. Newton, Chancery-lane—Improved apparatus for cooling and drying flour. (Communication)

2487. R. A. Brooman, Fleet-street—Improvements in fire-arms. (Communication)

Dated November 6.

2489. F. L. H. Danchell, Arthur-terrace, Caledonian-road—Improvements in apparatus for ascertaining the pressure of steam, air, water, or any other fluid or liquid

2491. J. Schloss, Wellington-chambers, Cannon-street West—A new mounting for travelling-bags

2493. S. C. Lister, Manningham, near Bradford—Improvements in weaving pile fabrics

2495. E. Jeffreys, Shrewsbury—An improvement in the construction of furnaces

Dated November 7.

2497. C. Hanson, Pimlico—Improvements in fire-arms

2499. J. Haley, Manchester—Improvements in the buffers and spring draw-bars of wagons or other railway vehicles, and in the application of the same

2501. W. G. Craig, Gorton, near Manchester—Improvements in bearing, buffing, and draw-springs, applicable to the rolling stock of railways and other vehicles

2502. W. Kenworthy, Blackburn—Improvements in steam-engine valves, and in the mode of working the same

2503. W. Davis, Northampton-place, Old Kent-road—Improvements in the construction and arrangement of furnaces and furnace bars for the better consumption of smoke and prevention of loss of heat by radiation

2505. W. Johnson, Lincoln's-inn-fields—Improvements in the manufacture and application of prussiates and other colouring matters. (Communication)

2507. W. Dray, Swan-lane—Improvements in apparatus for heating, baking, and drying

2509. W. Lund, Fleet-street, and A. Bain, Paddington—Improvements in pencil-cases

2511. C. A. Browne, Massachusetts, U. S.—A machine for manufacturing bricks. (Communication)

2512. H. J. Betjemann, New Oxford-street—Improvements in expanding or extending tables. (Partly a communication)

2513. G. T. Bousfield, Sussex-place, Brixton—Improvements in wrought-iron shafts for steam-boats, and other purposes where great strength is required. (Communication from O. Tufts, Boston, U.S.)

2515. T. Burgin, Great Winchester-street—An improved construction of ledger hand-rest

Dated November 8.

2517. C. Page, Ware, Herts—An improved construction of railway-signal apparatus

2518. L. Gasté, Paradis Poissonnière, Paris—Improvements in binding account and other books

Dated November 9.

2521. J. Raywood, Wentworth, Yorkshire—An improved rolling, dribbling, sowing, and harrowing machine for wheat and other agricultural produce

2522. G. B. Goodman and G. A. Webster, York-buildings, Marylebone—Improvements in apparatus for reflecting the back, front, and sides of the figure and head in a mirror or toilette glass at one view

2523. H. Fletcher, Manchester—Improvements in the manufacture of nuts, bolts, and other similar articles, and in machinery or apparatus for making the same

2524. J. Bramwell, Royal Exchange-buildings, and J. Crawford, Newcastle-upon-Tyne —Improvements in ordnance

2525. W. H. Walenn, Regent-street—Certain new and useful improvements in looms for weaving seamless bags and other open double fabrics of a similar character. (Communication from G. Copeland, Lewiston, U.S.)

2526. C. J. Hampton, Llynrivale, Llangynwyd, Glamorgan—Improvements in the manufacture of iron

2527. T. Pritchard, Walsall—Improvements in manufacturing welded iron tubes

Dated November 10.

2528. W. P. Piggott, Oxford-street—Improvements in galvanic, electric, and electro-magnetic apparatus, and in the mode of applying the same as a curative and remedial agent

2529. W. H. Bentley, Bedford—Improved cannon, guns, and other fire-arms, and appendages thereto, and in the capsules, cartridges, and projectiles for the same and other fire-arms

2530. J. Scott, Glasgow—Improvements in corking bottles, jars, and other receptacles

2531. L. Eskell, Cockspur-street—A new enamel for filling or stopping decayed teeth

2532. A. V. Newton, Chancery-lane—Improvements in transmitting fac-simile copies of writings and drawings by means of electric currents. (Communication from G. Casselli, Florence

2534. H. Wickens, Tokenhouse-yard, London—Improvements in locomotive steam-engines, and in apparatus in connection therewith, parts of which improvements are respectively applicable to other steam-engines and purposes

Dated November 12.

2535. W. Crosley, Westbourne-park, and Southwark Bridge-road—Improvements in gas meters

2536. J. C. A. Bouillotte, Paris—An improved letter copying-press

2537. L. J. F. Margueritte, Paris—Improvements in the manufacture of vitreous products

2538. W. K. Hall, Cannon-street—The prevention of steam boiler explosions

2539. W. K. Hall, Cannon-street—Improvements in boilers for generating steam. (Communication)

2540. G. Cooke, Kersley, Lancaster—Improvements in flyers used in roving and slubbing frames

2541. T. Hitt, Tavistock-street, Westminster—A new method of obtaining power for propelling vessels and certain new propelling machinery

2542. J. Y. Borland, Manchester — Improvements in spinning and machinery for preparing and spinning fibrous materials

2543. W. H. Aston and S. Hopkinson, Zetland Mill, Huddersfield—Improvements in steam-boiler furnaces and apparatus employed for supplying water to steam-boilers

2544. J. Kidd, Newgate-street — Improvements in machinery and apparatus for sewing or stitching and ornamenting cloth or other fabrics

2545. A. Barclay, Kilmarnock, Ayr—Improvements in indicating the pressure of steam and other fluids, which improvements are also applicable to governors and other regulating apparatus

2546. J. H. Johnson, Lincoln's-inn-fields—Improvements in casting metals. (Communication from Jackson Brothers, Petit, Gaudet, and Co., Rive de Gier, France)

2547. J. H. Johnson, Lincoln's-inn-fields—Improvements in the manufacture or preparation of hard india-rubber and in the application thereof to the construction of parts of textile and other machinery. (Communication from H. V. Wocrenier, Paris)

2548. W. C. Thornton and B. Thornton, Cleckheaton, York—Improvements in machinery or apparatus for preparing and spinning wool, which improvements are also applicable to washing and wringing machines for the same material

2549. W. Henson, Bryan-street, Caledonian-road, and H. O. Palmer, Castle-street, Marylebone—Improved apparatus for propelling vessels

Dated November 13.

2551. F. A. Wilson, Adelphi chambers—Improvements in engines, machinery, and apparatus for exhausting, forcing, lifting, and for propelling on land and water

2552. J. Homan, Milk-street, Cheapside—Improvements in machinery for cutting up woven and other fabrics

2553. J. Wilkinson the elder, and J. Wilkinson the younger, Leeds, York—Improvements in communicating a shape or configuration to felted cloths and other manufactured fabrics

2554. W. Webb and J. Webb, jun. and J. Catstree, Birmingham—Improvements in attaching door-knobs to spindles

2555. J. Mawson, Newcastle-upon-Tyne—Improvements in cameras for taking photographic pictures

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2556. F. A. Eakell, Manchester—Improvements in plates for attaching artificial teeth.
2557. R. Murdoch, Cran-hill, Glasgow—Improvements in agricultural apparatus for sowing seeds and depositing manure
2558. W. Foster, Black Dike Mills, Bradford—Improvements in machinery or apparatus for drying wool and other fibrous materials

Dated November 14.

2559. A. Tolhausen, Duke-street, Adelphi—Certain improvements in producing ice. (Communication from L. J. F. Marqueritte, Paris)
2560. H. Laxton, Arundel-street—Improvements in fire-arms. (Communication from B. F. Joslyn, Worcester, Massachusetts)
2561. J. Burrows, of the Haigh Foundry, near Wigan—Improved apparatus for winding coals or other minerals from mines, which said apparatus is also applicable for other similar purposes, and for machinery required for forming or constructing such improved apparatus
2562. T. Skinner, Sheffield—Improvements in producing figures or ornaments upon the surfaces of metals
2563. W. Barnes, Royal Exchange-buildings—An improvement in connecting and supporting the ends of the rails of railways
2564. C. M. T. du Motay, Paris—Improvements in the manufacture of lubricating materials
2565. J. Robinson, Denton-mills, Carlisle—Improvements in machinery for drying wheat and other grain
2566. C. M. T. du Motay, Paris—Improvements in the treatment of fatty and oily matters
2567. C. Goodyear, Avenue Gabrielle—Improvements in shoes and boots when india-rubber is used
2568. G. T. Bousfield, Sussex-place, Loughboro-road, Brixton—An improved safety coal-hole cover. (Communication)
2569. F. Jacques, Droylsden, Lancaster—The use and method of preparation of a new material to be used in the process of dyeing silk
2570. E. G. Cox, Lille, France—Improvements in picking or cleaning cotton, wool, and other filamentous substances
2571. A. V. Newton, Chancery-lane—An improved manufacture of electrotype printing surfaces. (A communication)
2573. J. Moller, Maynard-place, Hornsey—Producing a transparent photographic picture on ivory, without injuring the nature of the ivory, so as to be able to finish the picture with colours like other miniatures

Dated November 15.

2574. J. T. Pitman, Gracechurch-street—Improvements in the construction of iron beams and girders, and in machinery for making the same. (Communication)
2575. F. Duncker, King William-street, Strand—A new instrument for electric telegraphs, called "Despatch Distributor," which will permit despatches of various contents being communicated at the same time to one or more stations by means of one or two line wires only. (Communication from Mr. A. Bernstein, Berlin)
2576. J. L. Hinks, Birmingham—An improvement or improvements in brushes
2578. W. Lea, Wolverhampton—An improvement or improvements in taps or cocks
2579. J. H. Johnson, Lincoln's-inn-fields—Improvements in carding engines for carding cotton and other fibrous materials. (Communication from G. Wellman, Lowell, U.S.)
2580. D. Morrison, Bordesley Works, Birmingham—An improvement in the manufacture of articles with internal screws, when cast-iron, malleable cast-iron, or cast-brass is employed
2581. G. T. Bousfield, Sussex-place, Brixton—Improvements in breech-loading fire-arms. (Communication)

Dated November 16.

2582. C. Crum and C. Paul, Hudson, New York—Process for making bread
2583. B. T. Babbitt, New York—Manufacturing soap
2585. W. Eassie, Gloucester—Improvements in hammers
2586. T. Hudson, Warrington—Improvements in machinery or apparatus for cutting and punching metals, paper, leather, and similar articles
2587. J. Yates, and T. R. Birch, Birmingham—An improvement or improvements in engines for raising beer and other liquids
2588. J. Hinks and F. Dowler, Birmingham—New or improved machinery for the manufacture of percussion-caps, and for cutting out and raising articles in metal generally
2589. E. Peyton and D. Morrison, Bordesley Works, Birmingham—Improvemennts in manufacturing parts of metal bedsteads
2591. L. A. Potard, Paris—Improvements in manufacturing velvet and other similar fabrics

Dated November 17.

2592. J. Hosking, Gateshead Ironworks, Durham—Improvements in vertical direct-action marine-engines
2593. J. Denton, Pendleton, Lancaster—Improvements in looms
2594. H. Ball, Great Russell-street, Birmingham—An improvement in gun-sights
2595. R. W. Swinburne, South Shields—Improvements in furnaces used in the manufacture of glass
2597. G. Collier, Halifax, and J. W. Crossley, Brighouse, York—Improvements in means or apparatus employed in hot-pressing woven fabrics, and other surfaces
2598. G. Collier, Halifax and J. W. Crossley, Brighouse, York—Improvements in finishing fabrics and in treating yarns, part of which improvements is also applicable to producing ornamental effects upon other surfaces

Dated November 19.

2600. J. Fleetwood, Elm-grove House, Southsea, Southampton—An improved portable apparatus for making malt, and for drying hops, corn, and other grains and seeds
2602. W. Smith, Salisbury-street, Adelphi—Improvements in gas-regulators. (Communication)
2604. R. A. Brooman, Fleet-street—Improvements in apparatus for measuring liquids which may also be employed as a motive power-engine. (Communication)
2606. J. B. Ve Lopez, Rue de Bretague, Paris—An improved antibilious powder
2608. W. H. Preece, Bernard-street, Primrose-hill—Improvements in electric telegtaphs

Dated November 20.

2610. J. Poole, Riley-street, Chelsea—An improved mode of regulating the supply of steam from the boiler to the cylinder and thereby better governing the motion or speed of steam-engines
2612. A. V. Newton, Chancery-lane—Improved apparatus for dressing flour. (Communication from P. B. J. E. Cabanes, Bordeaux)
2614. W. Harvey, Mansfield, Nottingham—An apparatus to be employed with reels, cylinders, or rollers, and for placing upon or taking off therefrom hanks, skeins, bands, and other articles without removing such reels, cylinders, or rollers, from their bearings
2616. C. F. Clark, Wolverhampton, Stafford, and M. Bower, Birmingham—Improvements in bolts and fastenings, which they propose calling Clark and Co's Longitudinal Wedge Bolt
2618. D. S. Price, South Molton-street, and E. C. Nicholson, Newington-crescent—Improvements in the manufacture of cast-iron
2620. O. Maggs, Bourton Foundry, Dorset—Improvements in machinery for thrashing and winnowing wheat and other grain
2622. C. Defries, Hounsditch—Improvements in the roof-lamps for railway-carriages

Dated November 21.

2626. P. A. Lecomte de Fontainemoreau, South-street, Finsbury—Improvements in treating fatty acids. (Communication)
2628. H. W. Wimhurst, St. John's-wood—Improved machinery for cutting dovetails and tenons

Dated November 22.

2630. A. Tolhausen, Duke-street, Adelphi—Improvements in bombs and other explosive projectiles, whose charges are to be fired by percussion. (Communication from H. P. Herdman, New York)
2632. G. Price, Cleveland Safe-works, Wolverhampton—A box, chest, or case, for the preservation of parchment deeds and documents from damage by steam, when placed inside an iron safe made fire-proof on the vapourising principle. Milner's Patent, 1840
2634. H. Hibling, Norwich—Improvements in waterproof boots and shoes
2638. J. H. Johnson, Lincoln's-inn-fields—Improvements in apparatus for making aërated beverages. (Communication)

Dated November 23.

2640. T. Tuckey, Cork—Modes of construction, by which steam or other vapour or gas may be used as a source of motive power for some purposes more conveniently than hitherto, and more suitably for locomotion on common roads
2642. J. P. Fisher, Edgbaston, near Birmingham—Improvements in the construction of the hammers of pianofortes
2644. J. Ellisdon, Liverpool—Improvements in castors for cabinet furniture
2646. S. C. Lister, Bradford, and J. Warburton, Addingham, York—Improvements in spinning

Dated November 24.

2648. S. R. Carrington, Stockport—Improvements in the manufacture of hats
2650. J. J. Rowley, Rowthorn, near Chesterfield—Improvements in machinery for cleaning and cutting turnips and other roots
2652. J. Martin, Soho-square—An improved self-acting incubator
2654. H. Hyde, Truro, Nova Scotia—Improvements in the manufacture of mineral oils. (Communication)

Dated November 26.

2658. E. Harrison and H. Greaves, Manchester—Improvements in the manufacture of woven fabrics
2660. T. Greenwood, Leeds, York—An improvement in the construction of carding-engines
2662. G. E. Dering, Lockleys, Hertford—Improvements in galvanic batteries
2664. J. Clark, Billiter-street—Improvements in the chain-wheels used on capstans, windlasses, and other axes

Dated November 27.

2666. T. Allan, Adelphi-terrace, Westminster—Improvements in applying electricity
2668. H. Hyde, Truro, Nova Scotia—An improved manufacture of lubricating compound. (Communication)
2670. E. Tayler, Baldwin's-gardens, Gray's-inn-lane—Improvements in paddle-wheels for propelling vessels in water
2674. S. A. Kirby, Hastings-street, Leicester—Improvements in open stoves and grates for rooms and apartments
2676. J. H. Johnson, Lincoln's-inn-fields—Improvements in sheathing ships. (Communication from Messrs, Jackson, Brothers, Petin, Gaudet and Co., of Rive de Gier, France
2678. J. H. Johnson, Lincoln's-inn-fields—Improvements in cleaning and hulling grain and seeds, and in the machinery or apparatus employed therein. (A communication from C. T. Laborey, Paris)
2680. T. Warren. Glasgow—Improvements in the manufacture and moulding or shaping of glass

Dated November 28.

2682. C. H. Holt, Manchester—Improvements in steam-boilers, furnaces for the same, and apparatus connected therewith
2684. G. Richardson, Craig's-court, Charing-cross—Improvements in buffer, draw, and bearing-springs for railway carriages and wagons. (Communication)
2686. J. Lee, Stonall, near Walsall, Stafford—Improvements in agricultural or farmer's engines, which improvements are applicable also to locomotive engines
2688. W. A. Distin, Cranbourn-street, Leicester-square—Improvements in cornets and other wind musical instruments

Dated November 29.

2692. A. W. Forde, Bernard-street, Russell-square—Registering the number of revolutions of a wheel of a locomotive engine, or railway or other carriage at any given period
2694. W. Irlam, Gibraltar Iron-works, Manchester—Improvements in crossings for railways

Dated November 30.

2700. J. Ramsbottom, Accrington, Lancaster, and J. C. Dickinson, Blackburn—Improvements in machinery or apparatus for measuring and registering water and other fluids, and obtaining motive power from the same
2702. E. D. Johnson, Wilmington-square—An improvement in the construction of attachable seconds watches
2704. R. Hancock, Great Polgooth Mine, Cornwall—Cleaning and separating ores of every description when brought into a state of low pulverization
2706. S. C. Lister, Bradford—Improvements in treating so as to rework waste yarns of cotton, silk, flax, wool, or other fibre.

Dated December 1.

2708. W. Ward, Warrington, Lancaster—Improvements in loms for weaving
2712. J. M. Napier, York-road, Lambeth—An improvement in drying small coal

Dated December 3.

2714. G. Harrison, Burnley, Lancaster, and W. Mitchell the younger, Hoarstone-lodge near Burnley—Improvements in machinery for roving, spinning, and winding worsted, cotton, and other fibrous materials
2716. C. Mayer, New York—Improvements in hair trigger locks for fire-arms
2718. W. Richards, and J. R. Cooper, Birmingham—An improvement or improvements in breech-loading fire-arms
2720. J. Roth, Mulhouse, France—An improvement in rollers employed in spinning machinery, and in other parts of machinery used in the treatment of fibrous materials
2722. J. Leitch, Ellenborough-street, Liverpool—Improvements in melting and blowing up sugars

Dated December 6.

2742. C. Hawkes, Fishbourne, Isle of Wight, and T. P. Hawker, Plymouth—An improved method of manufacturing carriages

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PATENTS APPLIED FOR WITH COMPLETE SPECIFICATION.

2623. A. Tolhausen, Duke-street, Adelphi—Making metallic chains. (Communication from E. Weissenborn, New York). November 21, 1855
2747. E. Poulson, Judd-street, Brunswick-square—A new constructed engine to be worked either by steam or principally by manual labour. December 6, 1855
2792. J. E. de Malbeck, Paris, and Duke-street, Adelphi—Improvements in water-closets. December 11, 1855

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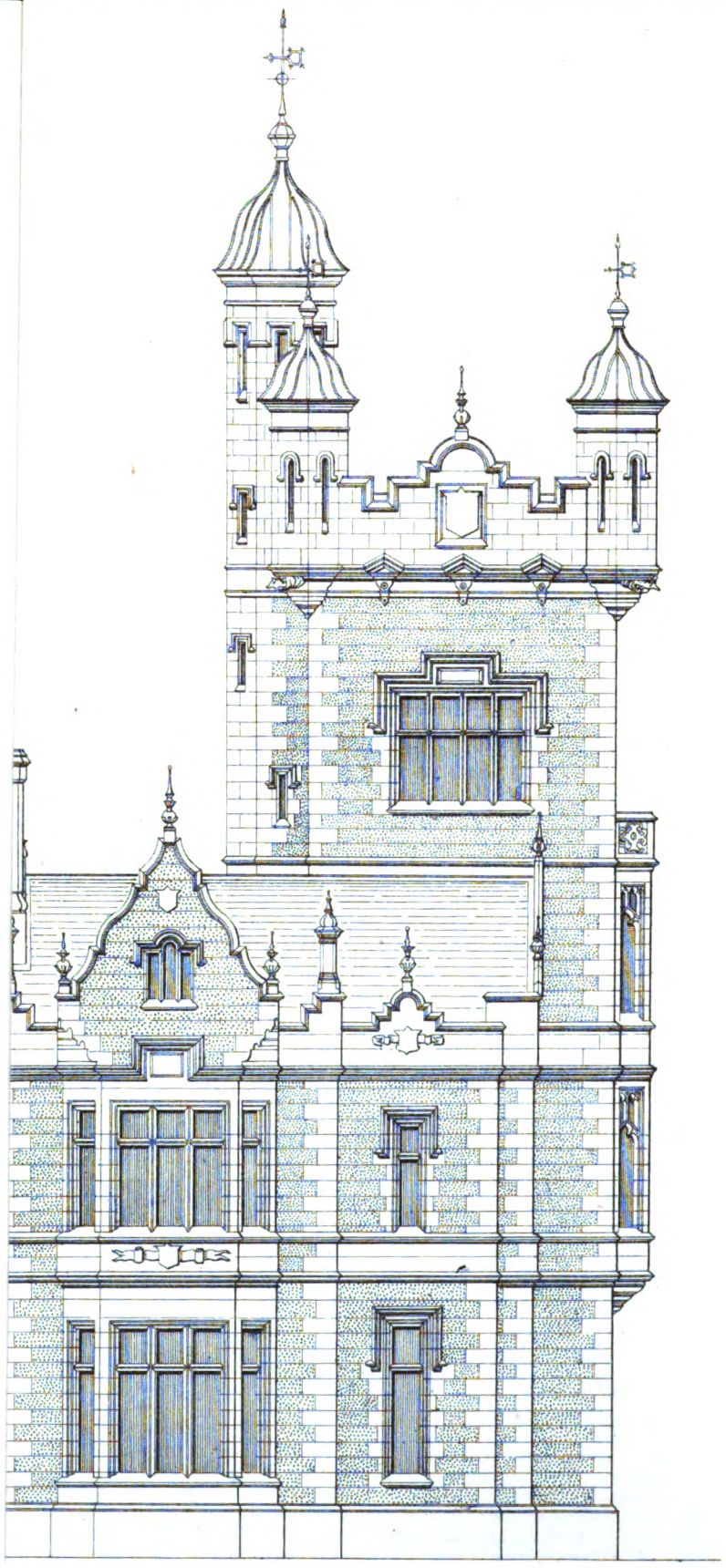

RT NAPIER ESQRE

J.R. Johnns.

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WEST SHANDON, THE PROPERTY OF ROBERT NAPIER, ESQ.

(*With an Engraving, Plate* III.)

THIS mansion is delightfully and picturesquely situated on the north bank of the Gareloch (an arm of the Frith of Clyde), and surrounded by magnificent plantations of fir and copsewood. The style of mansion house is a mixed Tudor and Elizabethan, built of the finest freestone from Kenmure Quarry, in the vicinity of Glasgow. The style of masonry is in 6-inch-course work, with polished relieved corners, cornices, mullions, and stringcourses. The external architecture partakes largely of the varied and picturesque character peculiar to the more effective and ancient examples of the style, alternately relieved by boldly-recessed and projecting parts, flanked by large and magnificent and wide-spreading oriels, carried up through the whole height of building, and terminating in richly quirked and fancifully designed gables, relieved by appropriate vases and pinnacle termini. The roofs are steep pitched, and the chimney shafts tall and appropriately broken up into groups. The extremities of the parapets are finely set off with square and angular turrets projecting from the wall several feet, and ornamented at the lower part, or springing corbel-stone, by grotesque gargoyle-heads. Those turret tops have copper coverings, with wind indicators and moulded spear points. The great entrance tower is square in form, and has an altitude of about 90 feet, with bold ashlar parapet and corner turrets similar to the others; access to the tower is by means of a circular stone stair, the walls of which are of solid stone, clean polished to the top of newel. The internal plan, economy of space and arrangements, were designed with much taste by Mr. Napier himself. The principal apartments are all *en suite*. The breakfast parlour is 24 feet by 20 feet; the drawing-room is 35 feet by 30 feet; the dining-room 38 feet by 33 feet;—the three last-mentioned rooms being T shaped on plan. The library is 40 feet by 19 feet; the picture-gallery 48 feet by 20 feet. Open tribune, or corridor, from 12 to 16 feet wide, in centre of which is a massive stone staircase, with elaborately carved scroll stair-rail of polished oak with massive pedestals at corners. The staircase is lighted by a large mullioned window, filled in with richly stained glass. The ceilings of the principal rooms are appropriately divided in panelled and drapered design, formed with moulded ribs on the plain surface of ceiling, and having pendant points and boss work to suit the arrangements of the suspended lights. The whole of these ceilings are painted throughout and filled in with emblazoned shields and heraldic insignia belonging to the Napier family. The whole of the furniture and fittings being chastely designed, and selected to be in keeping with the character and style of the architecture throughout.

The ornamental grounds around the house have been arranged with great care, and assume every form of broad and expansive grass lawn, terrace, and parterre, waterfall, bridge, and balustrade. The *tout ensemble* is at once a pleasing specimen of the age of Elizabeth, with much variety, beauty, and harmony in all its parts.

The plans of the mansion house of West Shandon were prepared by Mr. J. T. Rochead, architect, Glasgow.

ON SOME FRENCH CHATEAUX OF THE AGE OF FRANCIS I.

By EDWARD I'ANSON.

[*Read at the Royal Institute of British Architects, Dec. 17th*, 1855].

THE subject on which I am about to address you is one which has no recommendation of novelty. The buildings to which I shall refer are, I doubt not, perfectly well known to you all, either from having actually visited them, or from pictorial representations; but it is on the very fact of the popular appreciation of these buildings, and on the pleasant memory of sunny hours which may have been passed by you within their precincts, and which may now be in some degree recalled to your mind, that I rely for whatever interest may attach to the subject I have the honour to bring before you.

I had indeed selected, and in part prepared a subject of greater novelty to myself. I allude to the remarkable group of Byzantine churches at Perigueux and its environs, which have been touched upon by Mr. Petit in his Architectural Studies in France; and as I found they had been already fully described by Professor Donaldson, I have fallen back on a subject, which, though more familiar, is, in its kind, not less interesting. I do not purpose to give any detailed chronological account of the dates of these buildings, or of the history of the times in which they were built. It is now, I find, ten years ago since I had the honour of reading in this room some account of the history of Renaissance art and its professors in France; but the subject appears to demand that I should, as a preliminary, refer to that connection which arose between France and Italy consequent on the wars of Charles VIII., in 1494; of Louis XII., who, five years later, invaded Italy, and of Francis I., who, crossing the Alps, in 1515, there gained the battle of Marignan.

At that time, after ages of change and struggle, Europe had assumed nearly its present political division of kingdoms and states. Italy had reached a state of high cultivation; ancient literature, which had there never been wholly lost sight of, was revived; printing had just been discovered; religious inquiry had commenced, and the Reformation was about to take place; material riches had accumulated, society had become formed, and intellectual activity characterised the age.

In architecture the Alps divided two very different styles. On the north side, the colossal transepts of Beauvais were being built, and the lofty spire of that cathedral, which has long since fallen; whilst its cotemporaries, the spire of Antwerp and the unfinished tower of Mechlin, remain amongst the greatest works of any time or country. On the other side of the Alps, the great dome of Florence had been built, and the mighty fabric of Saint Peter's was progressing.

Irrespective of foreign influence, it is certain that Gothic art had outgrown itself; it had grown as a stately plant on the ruins of debased Roman or Byzantine art; at first slightly decorated by curling leaves, narrow, nervous, and sparse, as in our early English of Lincoln; developing itself little by little, growing more pulpy and full, as at St. Alban's nave or Beauvais choir; breaking out into more luxuriant branches, with the buds abundant, as in our early Decorated, and the flower expanding itself as in the days of our Edwards; until at last, in the full luxuriance of the French Flamboyant and the late German styles, both more beautiful and picturesque than our late Gothic, the flower had expanded sometimes to an unnatural size and bursting luxuriance, shedding its ripened seed; but whilst the flower grew, the original stem in French architecture had lost its form and significance; its roots had become crystallised into the most complex forms; in Germany the stem had been lopped and pruned, wreathed, intertwisted, and twined, until its early upward tendency was lost, and the style in both countries had grown into a still luxuriant but feeble condition. In this state it was ready to receive the impress of any new thought, and accordingly we find that no sooner had the French become acquainted, through their intercourse with Italy, with the revived classic architecture which flourished there, than they at once adopted it. Not that it had at first any perceptible effect on the structural character of their works, being only introduced as decoration; of which we have very excellent examples in the screen surrounding the lady chapel at Chartres, a Flamboyant work most elaborately and exquisitely wrought, with a profussion of ornament of the Italian Renaissance; and the arcade next the court yard of that part of the palace at Blois, which is of the period of Louis XII., the whole of which is one of the most perfect and characteristic specimens which exist of the late Gothic of that monarch's reign, and to which I shall again have occasion to refer.

The new style once having taken root was not, however, long in fully developing itself, and under the fostering patronage of Francis I., who ascended the throne of France in 1515, at the early age of twenty-one, it rapidly rose into great importance, and several remarkable works were produced which will always remain as models of true and original art.

Amongst the most important in point of size, and for its historical associations, may be noticed Fontainebleau, a spot not less known from its magnificent palace than from the natural beauties of the great forest which surrounds it. Fontainebleau, like most of the chateaux, is of old origin; an ancient feudal house, added to or destroyed, and new buildings raised in its stead. It was the favourite residence of Francis I., who made it the cradle of the arts, and the chief seat of his court; from his day to the present it has been connected with the history of the French kings, particularly so with the first Napoleon, and it owes much

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of its present splendour to the care of the lately deceased monarch, Louis Philippe. By his munificent patronage, Francis I. here founded and maintained a school, called after him the School of Francis I.; and by his liberality have become associated with this palace the illustrious names of Leonardo de Vinci and Benevenuto Cellini, Andrea del Sarto, Sebastian Serlio, Primaticcio, and le Rosso. Primaticcio was the artist engaged for the greatest length of time: he had a fixed salary of 1200 livres a year, besides many marks of royal favour, and was assisted by Gio. Battista Bagnacavallo, Rugieri da Bologna, Prospero Fontana, Damiano del Barbieri, and Nicolo dell'Abate da Moden, which names I cite to show how much was done to introduce the revived Italian art. Fontainebleau continued to be the residence of the king, who here not only encouraged the arts, but also greatly increased the library. All the buildings round the Cour Ovale are of the time of Francis I., also great part of the Cour du Cheval Blanc, which was either entirely rebuilt by him or very much altered. He here sumptuously entertained Charles V., and on the occasion of the birth of his grandson, afterwards Francis II., born of Catherine of Medicis, in 1543, he gave a great fête; and two years later, at a similar fête, in honour of the birth of a princess, Henry VIII. of England was represented by Admiral Lord Dudley. Francis died in 1547, and to the last, so great was his love of Fontainebleau, that in going there he was accustomed to say, "Je vais chez moi." Henry II., and Diane de Poitiers, his mistress, rather than his queen Catherine of Medicis, reigned at Fontainebleau, and continued the work which Francis had begun. Catherine de Medicis, during her long regency enriched Fontainebleau with statues, bronzes, and pictures; she made additions to the Cour du Cheval Blanc, and built a staircase in the place occupied by the present staircase du Fer à Cheval, which is a much later work.

The names of Henry IV. and Gabriel d'Estrée are next connected with the progress of Fontainebleau. Henry, besides other minor works, built the large court bearing his name, for the more convenient accommodation of his retinue; it is a distinct building, and wants much of the interest of the older buildings of the time of Francis. The other buildings of the palace are all of later date, and of a style on which our attention is not now engaged. Heny IV.'s eldest son, afterwards Louis XIII., was born at Fontainebleau, in 1601.

The chateau of Blois, the next to which I shall allude, is placed in the middle of the town. The most important part is of the time of Francis I., but it is highly interesting as a work of art of many ages, as well as from its historical associations. It is a considerable pile of building surrounding an open court, and referable to three very distinct periods:—one of or antecedent to Louis XII.; the second that of Francis I.; and the third one of a later date. Of the older buildings, are the Salle des Etats, a very fine room of the twelfth century, and the Tour des Oubliettes, part of the old castle, which is now masked by the works of Francis I.

Louis XII. was the first royal resident of Blois, but it had already undergone considerable alterations and improvements under his father, Charles Duke of Orleans, who was long a prisoner in England. Louis XII. was born at the chateau of Blois, and it was his favourite residence in after years. The exterior façade of the portion built by him was finished in the month of December, 1501. The whole of this building is a very remarkable work; it is of brick with stone dressings, and shows distinctly the incipient traces of the Italian Renaissance, to which I have before referred: it is considered by the French the most perfect specimen of late Gothic. As an example of domestic architecture, I know of nothing finer, and it has been very well given in a work published by Mr. Henry Clutton, in 1853. Louis XII. died in the year 1515, and the wing, known as the wing of Francis I., commenced by Louis, was carried on and finished it is said in three years. Next the court yard, its principal feature is its beautiful staircase; and the façade next the town rising from a rocky elevated base, and owing much of its dignity to the commanding site on which it stands, is a most graceful and dignified composition. The massive natural base on which it stands, supports a range of building consisting of three stories, surmounted by an open colonnade. The windows are, for the most part, deeply recessed and divided by flat pilasters, whilst three projecting windows, and one projecting balcony, diversify the general breadth of design in the happiest manner. The more modern portions of the palace were chiefly added by Gaston of Orleans, brother of Louis XIII.

Blois, which was in a very dilapidated state, has been nobly restored as to that part which is of the time of Francis I. This work is due to the care of the King Louis Philippe, and has been most ably carried out by M. Duban, at a cost of 400,000 francs. (16,000*l.*) All the external sculpture has been carefully and successfully renewed—the glazing entirely replaced—the floor paved with tiles (the best rooms with encaustic tiles); the walls lined and decorated, the wooden ceilings redecorated, and the panelling to various rooms, and some magnificent chimney-pieces restored, the whole interior coloured, and in some rooms richly gilt; some part of the exterior coloured and gilt; forming altogether the most perfect and pleasing example of the age of Francis I., which is in existence.

This building is now used partly as a museum, and partly for occasional festive meetings of the townsfolk, and at the period of my last visit, a few months since, its chambers, once the abode of royalty and long the favourite residence of the House of Orleans, had served as an elegant series of ball rooms for the inhabitants of Blois. The great feature is the noble staircase.

The next building to which I would refer, is Chambord, built in the year 1523, by Francis I. Henry II. continued the works, and it is said that these two kings had 1800 workmen employed upon them for thirty years. It was altered by Louis XVI., and disfigured by his architect Mansard, who divided the noble internal galleries into two stories, by wooden floors, and also materially altered the low building at the back, in order that it might accommodate the numerous retinue of the Grand Monarque. The building measures in front 80 toises, and is 60 toises deep; the four corners are flanked by four great towers; those at the back are now low, but in Ducerceau's view they are as lofty as the principal elevation, and thus materially add to the beauty and effect of the whole design. In 1749 they were low as they now are. The outer buildings enclosed an inner building, also flanked by four towers, the centre building is called the donjon. Each of these towers is 60 French feet in diameter. The central staircase is 30 feet in diameter, and from it radiate in the form of a Greek cross, four Salles de Garde, each 50 feet long, and 30 feet wide. These Salles de Garde are vaulted in stone, and have flat roofs. The panelling of the vaulting is ornamented with an alternate F and the Salamander; the roofs are ornamented by quantité de cheminées très ornées, quantité de tourelles et croisées qui semblent récréer la vue de ceux qui se promènent sur ces terrasses. The central tower about 100 feet high, is very much praised, the writer from whom I quote, an author of about a century ago, says it produces "le plus gracieux effet du monde." There are 13 staircases, and 440 rooms in the chateau. The design is attributed to Primaticcio, but that it is really his appears very doubtful.

At present, this noble building is by no means in a satisfactory condition. It belongs to the Count de Chambord, by some known and hopefully looked up to as Henry V. of France. His portrait hangs up in the little but excellent inn adjoining the palace, the only habitation, except a religious house, which obtrudes on its desolation. On my pointing it out to the hostess, she referred to it with an evident expression of hope, and looking forward to better days to come, and only answered my doubting remarks by saying—"Ah, Monsieur, au bon Dieu, toutes les choses sont possibles."

In 1793 it was despoiled internally, and greatly defaced externally; and the domain being about to be sold, and the castle broken up, in 1821, it was purchased by the people during the reign of Charles X., and presented to its present owner. Its situation is the very reverse of picturesque. It stands in a flat country, three or four miles from the banks of the Loire, and in just such a monotonous position as Wolsey, at about the same epoch, chose for his palace of Hampton Court. The fosses which anciently sourrounded it are now filled up, but can be easily traced; its last resident was Stanislaus of Poland (1725), whose apartments are still preserved in a habitable state, but all the rest of the building is utterly stripped of all internal fittings, and presents a scene of perfect desolation and departed grandeur, to which may almost literally be applied the touching verses of Hood—

"No dog was on the threshold, great or small.
No pigeon on the roof, no household creature,
No cat demurely dozing on the wall,
Not one domestic feature.
No human figure stirred to go or come,
No face looked forth from shut or open casement,
No chimney smoked, there was no sign of home
From parapet or basement."

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Ducerceau, who wrote as an old man, about 1560, thirty years after the building was erected, speaks of it thus:—

"La commodité du dedans a esté ordonnée avec raison et sçavoir. Car au milieu et centre est un escallier à deux montées percé à jour et entour iceluy quatre salles, desquelles l'on va de l'une à l'autre, en le circuissant; aux quatre encoigneures d'entre chaque salle y a un pavillon, garny de chambre, garderobbe, cabinet et montée. Plus és quatre coings de la masse de tout le bastiment se voyent quatre grosses tours, garnies à chascun estage de toutes commoditéz, comme chambre, garderobbe, privéz, cabinets et montée.

Notwithstanding what Ducerceau says about the commodité of Chambord, it is extremely difficult to understand how any comfort could have been found in it; all the large rooms being given up to the guards, and the remainder are very small, scattered, ill-contrived, and reached by long galleries or open staircases. Blois is much the same, but the principal rooms are of greater dimensions, and certainly better arranged. Chambord was a very favourite residence of Francis I. When the works executed during his reign were well advanced, it was visited in 1539 by Charles V. of Spain, when he traversed France; and in the declining days of Francis, it was much resorted to by his sister, the Queen of Navarre, whom Francis called his Marguerite des Marguerites. It continued to be occasionally resorted to by the French monarchs, and particularly by Louis XIV., who first came here that he might conceal his royal amours from his mother the austere Queen of Austria. The Grande Monarque visited the chateau for the last time in 1684.

Alfred de Vigny, in his novel of Cinq Mars, describing this building, says:—"on conçoit à peine comment les plans en furent tracés et dans quels termes les ordres furent expliqués aux ouvriers, cela semble une pensée fugitive, une idée brillante qui aura pris tout à coup un corps durable, un songe realizé." And another more recent writer, not less enthusiastic, says:—"quelle qu'ait été la pensée qui a enfanté Chambord, elle a sans contredit créé la Merveille de la Renaissance, cette époque qui a fait surgir du sol Européene tant de prodiges n'a rien inventé, rien laissé de plus beau et de plus saisissant." And another old writer says, the Palace of Chambord, "est bien le plus merveilleux en toutes piéces rares qu'il y ait en Europe, et comme abrégé de toute l'industrie humaine de son temps."

On a smaller scale than either of the preceding, is Chenonceaux. It was built by one Thomas Boyer, chamberlain of Louis XII., who, following the example set by Francis I., sometime after 1496, when he bought the estate, built the present chateau, or rather commenced it, for he died in 1523, leaving it unfinished; after which it became a royal palace, and the property of Francis I., who frequented it often with Catherine of Medicis. By Henry II. it was given to Diana of Poitiers, who rebuilt the principal façade, and constructed the elegant gallery over the river. This gallery is called the Salle des Gardes, but is said to have been built by Diana of Poitiers to communicate with the left bank of the river, "ou se trouvait un Sylvestre et plantureux boucage arrosé de fontaines et verdoyant comme un pré d'avril." On the sudden death, however, of Henry II., and the advent to power of Catherine de Medicis, Diana of Poitiers was obliged in 1560, to exchange the chateau for that of Chaumont, near the Loire. This same year, our Mary Stuart visited Chenonceaux. Catherine retained this chateau until her death in 1589, when she bequeathed it to Louise of Loraine, wife of Henry III. Chenonceaux is a simple building in its form, as indeed all the buildings of that time are. It is a parallelogram on plan, with a chapel annexed on one side, and the great wing extending over the river at the back. The chapel, like that of Ecouen, is built in what appears to have been the conventional ecclesiastical style of the day, very similar to the church of St. Eustace, at Paris. The principal façade is rather more massive in its treatment, the cornice more strongly marked than those at Fontainebleau and Blois. There is a round tower at some little distance in front of the chateau, but unconnected with it; it is of the same date, but its use as part of the building is quite problematical, unless it were, as at present, a lodge to the main building. This chateau is now private property, but may be seen even when the family is in residence.

I may cite also the Chateau of Anet, now demolished, which was the work of Philibert de l'Orme. In this building every resource of art was used to produce a perfect work. And the small portions which remain attest a great refinement, a marked advance on the works of Francis I.'s reign, and much elegance of design. The interior of the apartments were covered with panelling, executed with extreme care and richness under Jean Goujon, and the painted windows were the work of Jean Cousin.

Before Philibert de l'Orme had completed Anet, Jean Bullant was employed by the Constable of Montmorency to build the chateau of Ecouen; this is a fine work, but the architect in some portions has been too anxious to copy the antique servilely, not accommodating it, as had been done so well in some of the other buildings I have referred to, to the feudal form of building to which it is applied, and the steep roofs which surmount it. On this work, amongst other distinguished artists, Bernard of Palissy is said to have been employed. Ecouen is about six miles from Saint Denis; it is now used as a seminary for the daughters of the members of the legion of honour, and is not accessible to the public.

I may also here refer to the old façade of the Hôtel de Ville at Paris, a well known example of the era of Francis I. Ducerceau, who wrote during the regency of Catherine de Medicis, towards the latter end of the sixteenth century, enumerates and gives plates of no less than eighteen royal chateaux: Blois, Amboise, Villiers Costerets, Charleval, Les Thuilleries, Sainct Maur, Chenonceaux, Le Louvre, Vincennes, Chambourg, Boulongne dit Madrit, Creil, Coussy, Folembray, Montargis, Sainct Germain, and La Muette. Writing after the wars of Francis I. and his successors—the very wars which appear to have imbued the French monarchs of that time with their love of splendour, he says, "J'ay pensé ne pouvoir mieulx à propos mettre en lumiere ce premier Livre des Bastimens exquis de ce Royaume: esperans que nos pauvres François prendront, peult estre, en respirant, quelque plaisir et contentement, à contempler icy une partie des plus beaux et excellés edifices, dont la France est encores pour le iourd'huy enrichie." Of these some are of early date, and several are now gone—swept away chiefly by the ruthless hands of the destroyers during the anarchy of the French revolution. The Chateau of Madrit, built for Francis I. by Pierre Lescot, 1540 to 1550, must have been a very noble example; some of them, as the Chateau of Chantilly, have still an enduring name; of some, as the Chateau of Gaillon, built for the Cardinal d'Amboise by Fra Giacondo, a Venetian architect, and the Chateau of Anet, to which I have already alluded, fragments are preserved in the court-yard of the Ecole des Beaux Arts at Paris; and of some I have this evening offered you a more full account.

In considering the fine monumental palaces, perhaps one of the most striking features is the staircase. It was a feature which had received considerable attention from the later mediæval architects. All of them are constructed upon the principle, no doubt derived from the earlier turret staircases, of a central newel. There is a well known instance in the Flamboyant style of a beautiful wooden staircase leading to the organ gallery at the church of Saint Maclou, at Rouen, and another, not perhaps quite so well known, but which is a most elegant and elaborate effort both of taste and construction, a stone staircase in a house situated very near the cathedral of Strasburg, the design of which, with very excusable gallantry, is attributed to the daughter of the architect of the mighty cathedral; it is a work indeed requiring the utmost precision and nicety of constructive skill, whilst it is exuberant in fancy and decoration. We have also the two staircases of the Corps de Logis of Louis XII., and several other examples might be cited. The staircases of the chateaux we have been considering, are, however, generally of larger proportion than the earlier works referred to, and at Chambord, the architect has indulged his taste by building no less than thirteen staircases. One of the noblest external staircases with which I am acquainted, I believe the very noblest, is that at Blois; the spiral turn of the stairs is adopted as the leading feature of the design, to which all the rest is subservient; and whilst there is considerable massiveness and solidity of construction, the octangular form of the building and the inclined lines of the staircase intersecting give a remarkable playfulness to the design, and the great beauty of the sculptured decoration adds that prevailing grace which is one of the chief characteristics of the architecture of this epoch. The central internal staircase at Chambord, circular on plan, is also a very fine work; it is of considerable size, being 30 feet in diameter, and there is a double flight, one under the other. The central newel is not absolutely solid, there being a hollow core, which extends from the ground level up to the upper part of the beautiful central turret of the chateau. The double flight ceases at the level of the terrace, and a single flight continues to the upper part of the

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central turret. The decoration of the staircase is admirably carried out, the various capitals of the flat pilasters, adapting themselves to the horizontal and inclined lines of the entablature which they support, are all beautifully wrought. The angle staircases in the court-yard, of a somewhat later date than the central staircase, surrounded with open colonnades and crowned with dome-shaped roofs, surmounted by the fleur de lis, are also elegant compositions.

Certainly however the great feature of all these buildings is the roof. Ruskin has remarked, that the first and most characteristic feature in a building is a roof—that the first ingredient of a habitable building is the roof—and it has long been observed how distinctive a feature it is—and how, as a general rule, its inclination may be taken as a proof, if I may so express it, of its original geographical position. Now, in this country and in France, in the later times of mediæval architecture, the roof took a very different growth; with us it grew flat, in France and Germany it grew high and steep. Rickman observes, in his "Styles of Architecture," that in our late Gothic, one of the distinguishing features is the embattled parapet. The roof had at that time so generally become flat, that some relief and finish to the wall, and indeed, some breast-work or protection to those using it were required; and they copied the parapets of our castles, retaining by tradition, and probably for more richness of effect and diversity of outline, the battlement also; which became so indispensable a feature with our late mediæval architects, that they introduce it, as a decoration even on the transoms of the windows. Together with the four centred flat arches they used the flat roofs, and with the flat roofs embattled parapets, and the church towers were built without spires, and finished also with parapets.

Now in French Flamboyant, that latest and, to my mind, very beautiful school of French art, the proportion became more elongated; the flaming of the tracery influenced the upward growth of the building; the lofty narrow window also caused it to grow in height, and the roof grew with the rest of the building; and particularly on the tower, when spires had also fallen into disuse, the roof assumed almost the inclination, if not the place of the spire, and the conical roofs to the circular angle turrets were in fact true spires, but being somewhat less elongated in form retained the character of roofs. The roof with its overhanging eaves and the cornice which supported it, rendered the parapet unnecessary as a matter of ornament; and as the roofs were inaccessible except by means of ladders attached to the projecting hooks which we so commonly see on the steeps roofs of French buildings, the parapets were also unnecessary as a matter of use, and thus in French late mediæval work, the parapet is of very rare occurrence, indeed I do not remember any example of it. I allude rather, however, to these features of French architecture, because it seems to explain the tendency to high roofs, which to this day prevails in French architecture, and although they are incongruous when applied to strictly classical architecture, yet they are not so in connection with the particular style of these chateaux, and the extreme picturesqueness which they give wherever they are applied is quite a sufficient reason for their being maintained, and an inducement to harmonise the lower part of the building with the lofty roof, an effort to accomplish which is readily to be observed in many modern French buildings; and, indeed, all that appears necessary to attain this is to develope the predominance of the upward lines of the decorations, and to suppress the importance of the cornice, which in buildings where the roof forms the crowning ornament is not of the same importance as in classical buildings, where the roof is a very subordinate feature; and recurring to Ruskin's observation that the roof is the great feature of any habitable building, the architect of the French Renaissance would appear to have been fully imbued with this principle. I may, before leaving this part of the subject, observe that although the Italian architects employed at Fontainebleau had introduced and practised a correct proportion in drawing the human figure in the mural and other decorations in this school of design [for such Fontainebleau then actually was] the French artists, influenced by the traditional feeling of the Flamboyant school, actually elongated their human figures, and allowed this tendency to give a marked character to all their works.

Although in the buildings of the time of Francis I. there is a very evident reference to the revived schools of classical architecture, still there is no servile copy; indeed, there is no part of the decoration in particular which does not, more or less, bear a very distinct and separate character from its type. The proportions of all the mouldings of the cornices and string-courses at Blois, Fontainebleau, and Chambord, are very much exaggerated, as in Prout's drawings; they are all coarse, and but rude copies of the best Italian work; there is, however, a great vigour gained by this treatment, and the peculiar cornices of Chambord and Blois, although not to be compared in elegance with Italian work of the same time, yet have a rude and massive character which gives very considerable dignity to the whole work. The projection of the pilasters is small; the arch mouldings and architrave mouldings are generally delicate and of better profile than the main cornices and string-courses, and the decoration of the capitals and carved panels is of a character often of extreme delicacy, and always of great and peculiar beauty, and there is an exuberant fancy in their varied design. The representation of foliage is perfect, and the best adapted for architectural decoration of any school of art. Cyphers and emblems, figures and animals, are sometimes introduced, but the animal carving does not equal the flowing racy vegetable form of the foliage, and at Chambord it is certainly very inferior.

The buildings of this age are very much ornamented with the emblems and cyphers of their owners; a practice indeed, which, as to the cyphers, has been continued in France to our day to an extent much beyond what prevails amongst us. The F for Francis, surrounded by the Cord of Anne of Britany, and the Salamander his emblem, and sometimes his motto "Nutrisco et Extinguo," are common on all the works of his period, whether they are Renaissance as at Blois, or Flamboyant as in the transepts at Beauvais. H for Henry, and his emblem the Crescent, also the emblem of his mistress, which he did not scruple constantly to use on the buildings of his reign; at Chambord, indeed, no opportunity seems to have been lost of displaying the royal H and the Crescent interlaced, also the two ☾-☾ connected forming H and D, and at Fontainebleau they are even used in the chapel. The Porcupine was the emblem of the ancient house of Orleans; the Ermine of the house of Britany; une Cordelière, of Queen Anne of Britany; and the S with a Dart through it was the emblem used for the name of the mistress of Henry IV., Gabriel d'Estrees.

I might allude to other points of interest, and draw some comparison with our own palaces of somewhat similar character but of later date, and remark on the number, great extent, and magnificence of the royal domains I have so inadequately referred to; the use of which, even in imagination, never seems with us to have been contemplated except in the one instance of Whitehall, of which we possess so noble a fragment. But I now conclude, having accomplished the object I had in view of briefly calling to your mind the memory of a well defined and highly interesting class of buildings.

HORNCASTLE CORN EXCHANGE.

A company, a short time back, was formed to carry out an important improvement in the town of Horncastle, viz., the erection of a convenient Corn Exchange, the want of which had long been felt to be a great inconvenience.

A very eligible site, the "Three Maids' Heads Inn," was offered to the committee for this purpose, immediately adjacent to the existing corn-market, equidistant from the principal inns, and surrounded by the leading shops.

The project was most favourably received by the public, and the share list immediately filled up, and on the 30th April, the design of Messrs. Maughan and Fowler, architects, of Louth, was approved by the committee, and contract drawings ordered to be prepared and tenders advertised for.

On the 5th of June, the tender of Mr. John Goddard of Great Grimsby, for the erection of the buildings, exclusive of heating-apparatus, and gas and other fittings, at the sum of 1767*l.*, was accepted by the directors. The following other tenders were submitted for their consideration:—

	£	s.	d.
Carter, Horncastle	1818	0	0
Levitt, Louth	1890	0	0
Dales, Louth	1899	15	0

The Exchange Hall was ready for occupation in November last, and the remaining buildings are to be completed by the 1st day of April, next. The Hall, which is situated at the rear of the buildings shown on the elevation, is 61 feet long by 33

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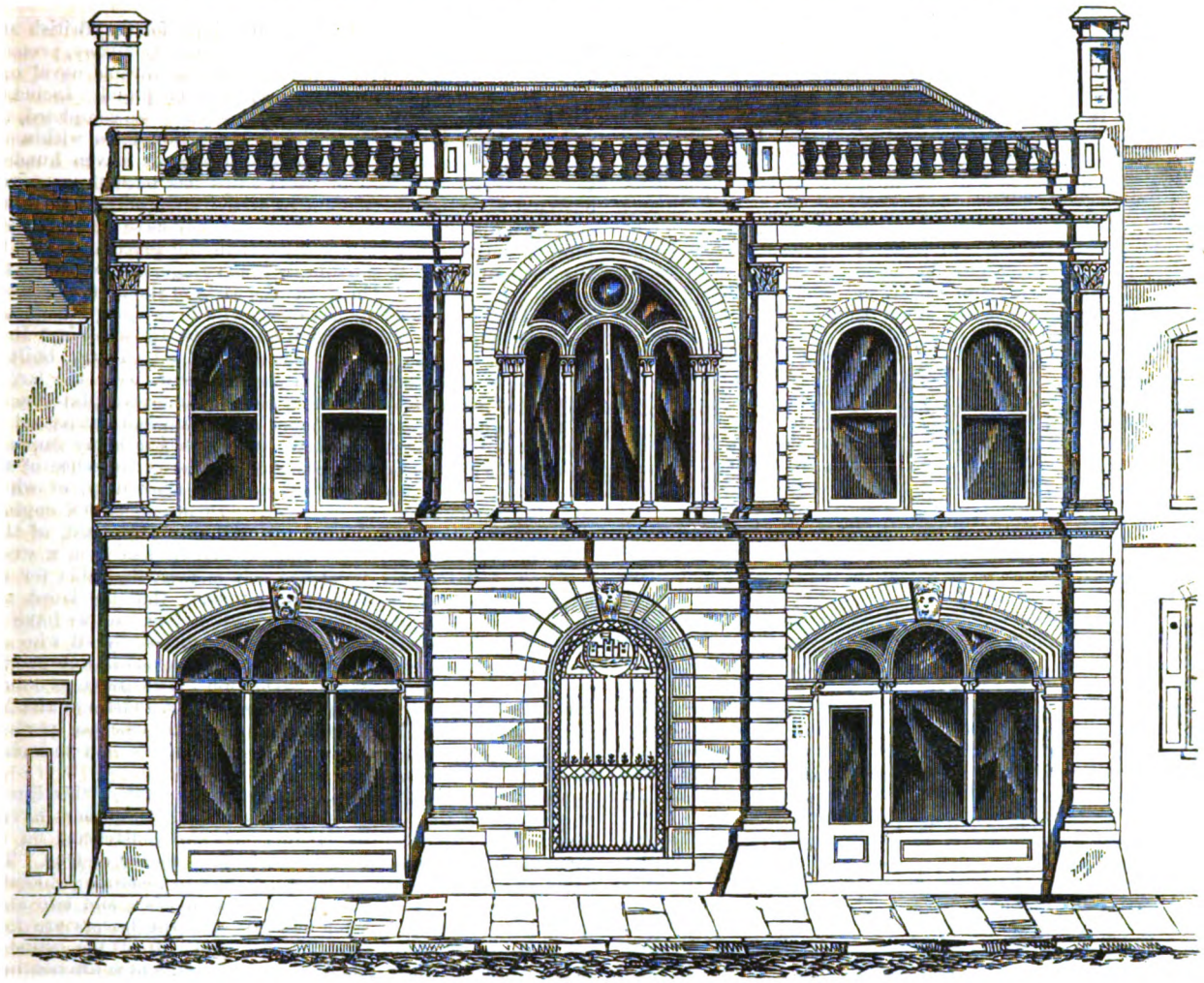
HORNCASTLE EXCHANGE BUILDINGS.——Maughan and Fowler, *Architects*, Louth.



wide; 27 feet high from floor to wall-plate, and 36 feet to the under side of the iron curb, carrying a lantern, 36 feet in length, 7 feet in width, and 6 ft. 6 in. high, the sides of which are glazed all round, and the ceiling formed in perforated panels for ventilation. The curb, which is of boiler-plate iron, is supported by 12 cast-iron ornamental girders, which also carry the remaining portion of the roof; this is divided by a moulded purlin and principal rafters into panels, the upper tier of which is glazed. Provision is made for heating the Hall by means of hot-water pipes conveyed in a trench in front of the merchants' boxes, the floor being perforated for the emission of the warmed air. A gallery, which may be used as an orchestra or for public speaking, is to be formed over the entrance-doorway, the full width of the room.

The buildings in front comprise, on the ground-floor, a news-room for subscribers to the Exchange on the left of the entrance, the other side being intended for a shop, and having a staircase at the back for access to two commodious rooms over, occupying the entire length of the frontage, and which, it has been suggested, would afford excellent accommodation for the Mechanics' Institute.

The street façade, represented in the above illustration, is executed in red stock bricks, with Ancaster stone dressings in the less exposed parts, and Yorkshire of similar tint in the plinths, sills, copings, &c. The relieving arches over the windows are of white brick, moulded for the jambs and heads of the windows in the side compartments of the upper story. The entrance-gate is of wrought-iron, with the rebus of Horncastle, from the ancient seal of the grammar-school, and corn-sheaves cast in the head.

The inhabitants of the locality are mainly indebted to the exertions of Samuel Sketchly, Esq., solicitor, of Horncastle, for the formation of the company; to whose energies may also almost entirely be attributed the connection of Horncastle by railway with the "Great Northern," at Kirkstead, the opening of which communication was celebrated with becoming festivities in August last, and which is expected to be of great advantage to the town and trade of Horncastle.

BRIDGE FOUNDATIONS.

Mode of Founding the Piers of the Ohio and Pennsylvania Railroad Bridge, across the Allegheny River at Pittsburgh. Solomon W. Roberts, C.E.*

The city of Pittsburgh and the city of Allegheny are separated by the Allegheny river, which is a stream about 1200 feet wide, and which sometimes rises to the height of 30 feet above low-water mark. Such great floods are, however, very rare, but a rise of 12 or 15 feet is a common occurrence, and the current is then very strong. The bottom of the river, to an unknown depth, consists of a mass of gravel, mixed with boulder stones of the size commonly used for street paving, and occasionally containing water-worn stones of a much larger size. The depth of the stream at low-water is very irregular, and while at some places the gravel bottom will be dry, at others the water will be from 15 to 20 feet deep.

The river is badly adapted to the construction of cofferdams, on account of the porous nature of the gravel bottom, through

* From the 'Journal of the Franklin Institute.'

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which water readily flows; and because they would be exposed to injury from frequent freshets, even if it was possible to pump the water out of the cofferdams, within any reasonable limits of cost.

In order to make the connection between the two railroads, the site selected for the Ohio and Pennsylvania railroad bridge is opposite the passenger station of the Pennsylvania railroad in Pittsburgh. It also has the advantage of convenient approaches on both sides of the river, without interferring with any valuable buildings. The bottom of the river at the site of the bridge is, however, very irregular, varying in depth at low-water, from 1 foot to 14 feet.

After the bottom of the river had been carefully sounded, and a correct cross section made of it, it was determined to found the piers by excavating pits for them, by means of a steam dredging machine working on a boat, and by sinking heavy cribs, or solid masses of large square timber, below low-water, on which to start the masonry.

This plan has been carried out with entire success, and with very little difficulty. Several of the piers, which are built of very heavy masonry laid in cement, are now approaching completion, and they show no signs of settlement whatever. The work in the river was begun on the 16th of August, 1854, and the foundation of the fifth pier was put in on the 5th of November following, being less than three months from the commencement of the work. The remaining pier is in shallow water near the shore, and the abutments are both upon dry land. The height of the piers from low-water mark to the under side of the bridge superstructure, is 38 feet, and the depth of the timber foundations under two of the piers, is 12 feet.

The pits, as excavated by the dredging machine, varied in depth from 5 to 13 feet below low-water, the object being to obtain a level and uniform foundation. Each pit was about 68 feet long and 28 feet wide on the bottom, and the cost of excavating and removing the gravel by contract, was 50 cents per cubic yard. By the careful use of the buckets of the dredging machine, and occasionally of a heavy iron rake, the bottoms of the pits were made very smooth and even. One large stone which could not be removed by the means at hand, was sunk in a hole dug for the purpose alongside of the pit.

The timber foundations were constructed of white pine timber, sawed square, and 1 foot thick. They were built afloat in the river, the first course of timbers being 24 feet long, and laid side by side, across the line of the pier. The second course crossed the first at right angles and was bolted to it with iron rag bolts. The third course, bolted to the second, ran in the same direction as the first. In this way an exceedingly strong foundation was constructed of solid timber, 3 feet thick, and large enough to distribute the weight to be supported over an extensive surface, 60 feet long by 24 feet wide. The masonry of each pier, at low-water mark, is 14½ feet thick, and its extreme length is 63½ feet, the ends being semicircular. The top of the timber foundation is 18 ft. 3 in. broad, and 65 feet long. After the first three courses of timber were laid, the additional courses were drawn in on the sides, by a succession of steps, so as to reduce the timber work to these dimensions on the top; and the upper course was planked with 3 inch plank, on which the masonry was started.

Experience showed that where the water was deep, and the foundations consisted of a good many courses of timber, it was expedient to leave some spaces between the timbers and fill them with stone, so that the whole might be but little lighter than an equal bulk of water, in order that the top of the timber foundation might float but little above the water, and be about level with the decks of the flat boats loaded with dressed stone for the pier, which lay on each side of the foundation to steady it. The first course of the pier masonry was thus laid in the most convenient manner, the river being low; and the weight of the stone work sunk the foundation down upon its permanent bed and in its appropriate place. The men were not required to work in the water, and all expense for pumping was avoided.

After the foundations were thus sunk in the manner desired, a large quantity of heavy loose stone, or rip rap, was placed around them, to secure them from the scouring action of the river.

The durability of the timber is secured by its being always under water, and of the performance of the structure there is no doubt.

MACHINERY OF THE "ARABIA" AND "LA PLATA." *

THE magnificent fleet of steam-ships built for the British and North American Royal Mail Steam Packet Company, presents an example of commercial enterprise and admirable naval construction of which this country may well be proud. Including the great leviathan "Persia," which has just been completed, the company has had built fifteen first-class steam-ships within the last fifteen years, the smallest of which exceeds eleven hundred tons burthen. The size of these ships has been progressively enlarged since the commencement of the undertaking: each succeeding ship, or each pair of ships—for they have generally been built in couples—has been greater than the preceding ones, till the last, now about to start on its first voyage, is three times the size of the "Acadia," which was the earliest afloat of this steam fleet. Of these ships four have been sold to foreign governments, one was lost, and another has been bought by the West India Royal Mail Company. The "Arabia" and "La Plata," built in 1852, each 2292 tons, builders measurement, were the largest previously constructed for the North American Mail Packet Company, and until the "Persia" was launched, surpassed all the others. In those two ships are comprised many improvements in the general arrangements for the convenience of the passengers, and in the construction of the machinery, of which Mr. R. Napier was the engineer. Drawings of the engines, which are among the largest and the most successful of that eminent engineer, have been made by Mr. Kirkaldy, on a working scale, and recently published. It is most desirable for the advancement of naval engineering science, that the latest and most perfect works should be thus made public; and we have no doubt these drawings will be carefully studied by all who are engaged in similar constructions, and are anxious to improve the application of steam-power to navigation. The drawings occupy nine large plates, beautifully engraved by Mr. Petitcolin and Mr. G. B. Smith, and comprise sections of all the essential parts of the machinery, some of which are on a scale of half-an-inch to the foot.

The "Arabia" and "La Plata" are the first of this line of steam-packets that have tubular boilers, all the others having flue boilers. Those of the "Persia" are also constructed on the same plan, but the latter has eight boilers instead of four. The arrangement of the boilers by Mr. Napier in these ships likewise differs from the rest by having two placed afore and two abaft the engines, instead of being all abaft, and the boilers are fired athwartship instead of fore and aft. The size of the cylinders indicates the increased power of the engines, which are not only absolutely more powerful than those of the "Acadia," and of the ships first placed on the line, but are more powerful relatively to the increased burthen. The cylinders of the "Acadia," were 72½ inches diameter, with a stroke of 6 ft. 10 in.; whilst those of the "Arabia" and "La Plata" are 103 inches diameter, with a stroke of 9 feet. The collective nominal horse-power of the first four of this steam fleet was 403; and that of the two latter 873, their tonnages being respectively 1148 and 2292. The nominal horse-power of the "Persia," which made its first sea voyage from Glasgow to Liverpool at the rate of 19 miles an hour, is absolutely less than that of the "Arabia" and "La Plata," being estimated at 850, though the tonnage is upwards of one-third greater.

Accompanying the drawings there is a description of the machinery, but without the plates it would be unintelligible. The following description of the internal arrangements of the vessels presents a complete view of the ample manner in which the wants and comfort of the passengers and crew have been considered:—

On *Main-deck* (commencing at the stern) are situated the wheel or steering-house, with the captain's sitting-room on the one side, and the chief officer's state-room on the other, passage, dining-saloon (60 by 18 feet); lobby, with stair on one side leading to the ladies' cabin, and a stair on the other side leading to that of the gentlemen's, steward's bar and pantry; smoking saloon, with hatchway to afterhold and stokehole stair, two capstans, funnel, crank-hatchway, officers' mess and purser's rooms, cooking-galley, engine-room stair, funnel, stokehole stair, engineers' mess and chief engineer's rooms, officer's and surgeon's rooms, steward's bar, lobby, with stairs to state-rooms below; saloon (30 by 18 feet); passage, with hatchway to forehold, forecastle, with

* Machinery of the British and North American Royal Mail steam-ship "Arabia," and of the West India Royal Mail steam-ship "La Plata." Constructed by ROBERT NAPIER, Esq.; drawn and described by DAVID KIRKALDY. W. Mackenzie, London, Edinburgh and Glasgow.

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thirty seamen's berths, capstan, &c. Between the deck-house in the centre and the bulwarks, with an intervening passage, are situated (before the paddle-boxes) bath, water-closets, cow, sheep, and ice-houses, with rooms for boatswain, carpenter, &c.

On *Cabin-deck*, extending from stern to aft engine-room-bulkhead, are the ladies' and gentlemen's sitting-saloons, with 36 state-rooms (two berths and sofa ranged fore and aft in each), captain and Admiralty agent's state-rooms, with accommodation for servants, water-closets, &c.; engine-room; engineers' rooms, with 6 berths, firemen's room, with 40 berths; fore-cabin, with 22 state-rooms (2 berths and sofa placed fore and aft in each); second-class cabin, with 4 rooms, 4 berths in each, and 2 rooms, with 2 berths in each; servants' room, with 18 berths.

On *Lower-deck* are situated the specie-room; cargo-space, with wine and spirit rooms, and trap-stair to magazine; coal-space, engine-room, coal-space with anchor-chain-lockers, cargo-space, grocery and general store-rooms, mail-room, sail and rope stores.

In *Hold*, large water-tanks, coal-space with powder-magazine in the centre, doors in bulkhead for passing the coals into the stoking-space between the boilers, engine-room, coal-space with doors in bulkhead, cargo-space.

Total accommodation for passengers amounts to 116 first and 20 second-class, in all 136 fixed berths, independent of sofas. Captain's department, 42; engineer's 47; steward's 26; total for officers and crew, 115 berths. Coal-spaces contain about 1250, and cargo about 600 tons. The roof of deck-houses extending the whole length of vessel, together with the space on both sides of the saloon, on the main-deck, afford ample accommodation for walking, working the ship, &c.

The state-room, &c., are lighted and ventilated by glass louvres opening into the passages, which communicate with the open air above through a continuous lateral opening under the sofas in the saloon, &c., also by the port-windows in ship's sides. Engine-room-bulkheads are of iron, with a lining of wood on side next cabins, and an air-space between through which circulates a current of fresh air admitted by openings in the lining, and withdrawn through gratings in the bulkheads into the engine-room by the strong draught caused by the boiler fires. The cabin floors are lined underneath with wood, with thick cloth between, to prevent the smell from bilge-water, &c., penetrating to the cabins. Saloons and state-rooms are heated by steam through pipes leading from the boiler steam-chests. As a security from fire, the candle-lamps for lighting the state-rooms are locked in, and so arranged that each one lights two rooms, and also the passage; and with a similar view, the funnels are surrounded with water-casings, extending through the ceiling of deck-houses. Water-hose pipes, connected with the pumps in engine-room, can be led to both ends of vessel for extinguishing fire and washing decks.

Besides the water contained in the tanks, a constant supply of fresh (for cooking and drinking) is obtained by distilling sea-water, by means of two stills bolted to the inside of the paddle-boxes. The spray from the wheels acting against the flat sides of the still, condenses the steam led into them from the boiler steam-chests. Pipes convey the water into tanks in the sculleries. Two small pumps, worked by the engines, supply the water-closet-tanks.

The frame-timbers of the hull are all of the best oak, fitted close together at the floors, and caulked tight; the timbers being bolted together in pairs, and becoming less as they approach the gunwale, a space is left between each frame. On the inside, and let into the frame-timbers, are a series of iron braces or strops, one set running diagonally in one direction from the main-deck beams to the bilges, and another set diagonally in the opposite direction. These strops are securely fastened to the timbers and outside planking by bolts. Above the strops are the ceiling planks and stringers for supporting the deck-beams at their respective heights. Over the outside-planking, with hair-felt between, is a doubling or sheathing of rock elm, and over all the copper sheathing. The main-deck and cabin-floor beams are of oak, lower-deck beams of red pine; all the decks of yellow pine; wing-wales, and fore paddle-beams of oak and greenheart; stringers for the various deck-beams, centre, engine and boiler keelsons, stem and stern-posts, are of oak; keel, and false keel, of rock elm. The engine-room-bulkheads; coal-deck over the boilers, with its beams; aft paddle-beam, and the two beams for binding together the sides of ship in the engine space, are all of malleable iron. The whole of the knees for the beams are also of iron. All the bolts are of copper, as far up as the outside doubling; above that they are of iron.

As the best preventative against dry-rot, great care was bestowed in securing a free circulation of fresh air throughout the entire framework of the vessel, by means of chamfering the edges next the frames of all the external planking and internal ceiling; the edges of the timbers in the centre of frames towards the planking, and also towards the ceiling; and by leaving an open space below the stringers for the various decks. Access to the open air above the main-deck is obtained by holes bored half-way up every alternate stanchion, and passing out on the aft-side; the entrance of water being prevented by short inverted tubes fastened over the opening. Rock-salt having also been found beneficial in preserving the wood, is placed in the spaces between the frames.

The vessels have two masts, are brig-rigged, with standing bowsprit; carvel-built; round-stern and bust figurehead.

SELBY WATERWORKS.

The water supply is obtained from an Artesian well, sunk to the depth of 10 feet, and cased with bricks set in cement, with a cast metal plate at the bottom, and then bored 320 feet below the metal plate. The bore-hole is cased from the top with 76 feet of cast metal pipes: the first pipe is 13 inches in diameter and 10 feet deep; the second, 10 inches in diameter and 18 feet deep; the third, 7 inches in diameter and 54 feet deep. The last 244 feet are bored through the new red sandstone formation. At this depth was found an abundant supply of excellent and comparative soft water, suitable for all domestic purposes. This bore-hole is capable of supplying 20,000 gallons per hour. The water is raised by a high-pressure steam-engine of 15-horse power, into a cast metal tank, 54 feet × 34 feet × 15 feet deep, which contains 155,000 gallons.

The tank is placed upon an ornamental brick building of sufficient altitude to give an average working pressure of 75 feet. This building is considered to be one of the best specimens of brickwork extant.

The diameter of the water-mains vary from 8 to 5 inches, and sub-mains from 4 to 2 inches, with hydrants or fire plugs at every 100 yards, and provided with 200 yards of hose and three hand-pipes, which discharge immense volumes of water over the highest houses in the town. The supply is constant both night and day. The house-service pipes are galvanised-iron, which appear to answer well.

The works were designed by the late firm of Messrs. Lee and Stevenson, Duke-street, Westminster, assisted by Mr. J. Linton, resident engineer. The steam-engine and the cast metal tank only have been executed by contract, all the other works have been erected by workmen employed by the local board, under Mr. Linton's direction and superintendence.

The water-rate for a cottage of 5*l.* rental is 2*s.* 8*d.* per annum; 10*l.*, 5*s.* 4*d.*; 20*l.*, 10*s.* 8*d.*, and so on in proportion.

DRAKE'S ATELIER, BERLIN.

This sculptor, whose works have acquired for him, within the space of a few years, a very considerable reputation, inhabits a little retired cottage of the Thiergarten of Berlin, which has been thus described of late by a German cotemporary:—"Although autumn rules surrounding nature, still there is a place around Berlin, where eternal spring reigns in a little cottage, which, built of rural materials and surrounded by a homely garden, appears more the abode of a gardener. And it is a *cultivator*, at any rate, with his eternal spring, who dwells therein: Drake, the sculptor—with all his noble charming works." On entering the house, we perceive the fine frieze which surrounds the pedestal of the marble statue of Frederick William III. in the Thiergarten. Here it is placed in a novel, ingenious way, around a vase of the noblest proportions. This, perhaps the finest basso-relievo of modern German art, has been designed by M. Meyerheim, and M. Andorff is just engraving it in copper.—Next, a yet unnamed, yet completed statue, attracts attention; it is the colossal model of the zinc statue, to be placed on the pediment of the new Museum of Berlin. M. Drake has not been deterred by the comparative poverty of the metal in which it is to be cast, but has perfected his model as if destined for the finest marble. A female of full—nay, of luxurious proportions; simple, stern, tranquil, elevated, as are all the statues of this master, who has redeemed sculpture from the attitude of dancers, and brought it within the pale of perfect nature.—The next work upon which M. Drake is engaged is one to be executed in the finest Carrara, viz., the monument to be erected to Prince Putbus by his wife. The small plaster model shows us the natural grace and nobility in which a delicately organised and nobly developed personality presents itself in organic matter—and thence in life-like plastic. —Another work of Drake's, now in progress, is for the bronze statue of Frederick John, Duke of Saxony. It will be cast in bronze for the University of Jena. Here is depicted the royal protector of a new doctrine—that of Luther; his left hand holds an open bible, while the right uplifts the protecting sword.—Drake's portly figure strides congruously amongst these his kindred creations, verifying that old and popular saying: "a great man."

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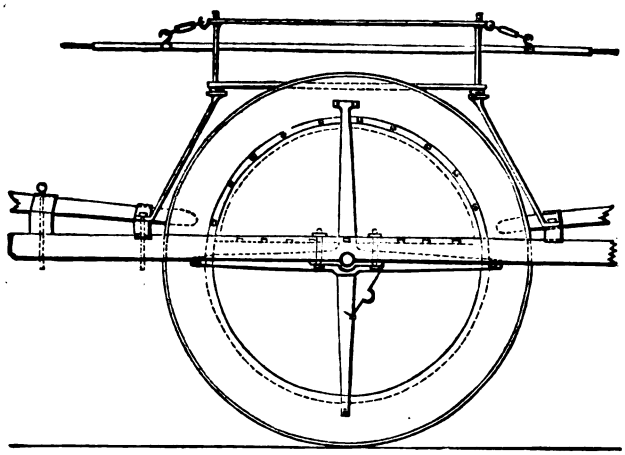
KING'S CYLINDRICAL CART.



The accompanying engraving represents a military pontoon, store, and water-cart, constructed by the inventor, J. C. King, of Portland-road, London, by order of the Minister of War, upon approval of the Ordnance Select Committee, Woolwich, where it is now undergoing experimental trials.

In the construction of this cart, the ordinary wheels and axle are dispensed with, the body, which is a hollow revolving cylinder, forming a substitute for them, thus enabling it to pass easily over soft ground without becoming imbedded; and as the horse has but to balance the shaft-frame, it is never distressed by the weight of the load, which rolls on the ground. The cylinder is 4 feet long by 3 feet diameter, raised a few inches from the ground upon felloe-rims at each end; it is made of galvanised sheet-iron, sufficiently strong to resist the concussion of any obstacles it may have to pass over. Half of one end of the cylinder is made so as to remove, or to close into vulcanised india-rubber rabbetts, and is secured by screwed nuts, which render it air-tight. This opening is intended for the reception of clothing, food, ammunition, &c., when used as a store-cart. As a water-cart it will contain 175 gallons of water, which may be drawn off or filled by means of a plug-tap in the end.

A cross stay and projecting spindle at each end of the cylinder form the turning points, and serve to attach the cylinder to the shaft-frame, by means of a hinged bedding plate, fixed on each underside of the frame, and fastened by two screwed nuts. By simply unscrewing these nuts, the frame may be detached from the cylinder so that it may serve as a store-box or moveable shed, having an internal capacity of 28 cubic feet.

For carrying four men along the road, or across a stream, a seat is fitted up over the cylinder, by means of light tubular iron stays, fixed to the shaft-frame. The shafts are moveable, and made so as to fit into sockets at either end of the frame. The seat and foot-boards are adapted to carry stores weighing half a ton. From four hooks at the top corners of the seat-rails, a litter, suspended upon vulcanised india-rubber springs, forms, when required, an ambulance, so easy in its motion that the inequalities or obstacles of the ground are imperceptible to any one riding upon it.

As a pontoon, it will support six or seven hundred weight in water. When used in the construction of a pontoon bridge, it is proposed to have a double row of these carts across a stream, with the shafts of one row interlapping those of the other row, and planked over to form the roadway, which would support the passage of infantry or cavalry.

It has been tested in the presence of scientific and practical men,—in water as a pontoon, and over very rough ground as a cart, loaded with 15 cwt. of water, drawn by one horse; the result was highly satisfactory in every respect. Its weight is about 5½ cwt. Its cost would probably be less than that of the ordinary cart, if generally adopted.

We believe it is proposed to apply the invention to railway and agricultural purposes as a revolving truck, and as a manure cart.

THE ARCHITECTURAL EXHIBITION, SUFFOLK-STREET, PALL MALL.

(*Concluded from p. 4.*)

Churches.—There are hardly so many drawings of this class on the Exhibition walls as we are accustomed to see, and this is really a relief. The mania has too long existed among those who imagine they possess a few architectural notions, of trying the experiment in shaping out fanciful churches (at least upon paper), while, aided by the authentic and "orthodox" models which publishers have supplied to hand, they have produced little else but new combinations. The conviction, however, which is now gaining ground, that these models, so carefully delineated ought to serve rather as suggestive text-books than cut-and-dried materials, has greatly checked these ambitious aspirers or devotees of reproductions, and turned the stream of art into its more legitimate channel. Of those which come under our view on the present occasion there are very few of first-class merit. In some lithographs (311, 313, 316) the proposed restorations—and very beautiful ones too—by the late lamented Mr. R. C. Carpenter—of St. Patrick's cathedral, Dublin, are minutely shown; and in (389, 390) are views of the same gentleman's successful alterations at Sherborne. Among important parochial edifices we have Bridgewater church (46), quite metamorphosed by the so-called restoration; Rochdale parish church (327), as altered by Mr. Joseph Clarke, which, beyond its squat proportions and long-drawn aisle, extending the full length of chancel, has nothing worthy of remark; and one or two others.

For the most part we find small village churches, some tasteful and pleasing, such as Mr. Christian's, at Tiptree (24, 355) of which both exterior, interior, and plan are given. The latter is of the simple rectangular form, rather broader than usual, and having the eastern end marked by the addition of a polygonal apse. Were we disposed to find fault, it might be asked how so simple a plan issues in so broken and somewhat constrained an elevation. It may, we are aware, be defended by some on the score of ingenuity; but to torture a plan for the sake of picturesqueness is surely unnecessary and inexcusable. In the present case the nave and aisles are roofed in one span, while the eastern bay of the aisle is gabled southward, giving the appearance of a transept flush with the wall; a lean-to vestry fills out the block of the walls. The interior is in better keeping. That part of the roof which covers the nave is arched and boarded, and a slight relief of decoration forms a margin against and along the projections of the principal timbers. (18) is a charmingly coloured drawing, making the most of a rather ordinary design, and over-spotted with ornament. The tower is a prominent object, but its belfry-stage is altogether a mistake. What can be the effect of weathering back the thickness of a wall all round, and, then, at half way up, corbelling out on the angles lofty slender pinnacles, but an uncomfortable topheavy look?—disturbing what should be the gradual tapering of the steeple, and, what is quite as bad, a violation of good construction.

Mr. E. B. Lamb's mannerisms and predilections are generally observable in his works, notwithstanding the clever versatility they always display. On former occasions we have ventured to object to his churches almost *in toto*, and we regret to have no occasion now to change our opinion. The "Memorial" church at Thirkleby (48), beyond a certain agreeableness of outline, has nothing in the least degree consistent or suitable. It is not often that Norman churches are now erected, but Mr. Norton has a view (49) of a small one lately finished near Aberystwith. The general form and details seem correct, except that for a cross church in this style the tower is carried up too high, while the finishing above is unsatisfactory, being neither by a pyramidal roof nor a decided spire. The church at Penzance, by the same architect (320), is an unpretending structure, having a nice little bell-turret at one end. The same may be said of Abertileg new church (463). The now undesirably notorious Bedminster church is represented in (493), and its *vexata quæstio*, the reredos, is photographed in two views (486). In the design of this latter there is a tendency to exaggeration, and perhaps redundancy of enrichment, but there is a considerable amount of taste shown in the composition, all except in the arcading below, which is quite out of place, and of a different character. Mr. T. Little's "Church in the Albert-road, Regent's-park" (101, 132), is well and favourably known. In the interior, particularly, there are many points of commendation, considering the time at which it was built. Galleries are introduced, lighted by spherical win-

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dows, thus showing two ranges of lights externally. These drawings are both excellently tinted. (104) "A proposed New Church," by H. Lote,—with all its attempts at prettiness of detail, is a very feeble production.

The views (112, 113) of "St. Paul's, Tottenham, about to be erected," by Mr. C. Gray, are so out of the common as to call for particular notice; independently of which, they contain some good ideas. The general mass is well managed (perhaps the tower is hardly important enough), and the arrangement of materials, principally brick, shows that the whole has been studied with an eye to effect. Why it is purposed to terminate the west as well as east end by a semicircle, does not appear;—as a novelty merely it might be undesirable;—and the little doorway which stands in the place of the principal entrance, is really insignificant. The south porch projects in the ordinary way, and has open sides, consisting of a double row of iron columns, which support the gable and roof. There is an appearance of weakness about this arrangement, though no doubt practically equal to its purpose. The windows are chiefly small coupled lights. In the interior of the church the arches are quite square on the soffit, only that a chamfer is taken off the edge, which is studded with flower-pateræ. The chancel-arch is equally simple, and, like the others too, is slightly cusped or trefoiled, instead of being in one sweep. A continuous arcade connects all the windows of chancel. (141) the "Free Church, Kentish-town," by Wetten and Harris, "will accommodate 500 persons, and cost 4000*l*." It is of brick, with very steep gables, and slender windows, quite plain in details except the west doorway, which verges to the other extreme; the walls are faced internally with white bricks, tuck pointed. Mr. T. D. Barry's "Tulse-hill Church" (186) has some bits of original treatment, but greatly lacks consistency of style.

"St. Luke's church and schools, Sheffield" (321), by J. Billing, are wretchedly poor; the gable-end of the church might be passable, but for the paltry freaks of the string-moulding above the doorway. Mr. Brown's "Design (328) for Torquay Church" is quite of the old jog-trot kind. Close to this latter we discern a drawing which it would be vain to attempt to describe. Under the winning title of "Decorative brickwork applied to the exterior of a Building, without disturbing the lines of Architectural Design," we are treated to one of the most sprawling, ungain masses that can be imagined, but doubtless meant for a church. Setting aside the crude forms into which they are crammed, the individual patterns into which Mr. Stride has distributed his bricks, are in the main good, but we sincerely trust never to behold them in such a medium as the author (seriously, it is to be presumed) recommends for adoption. Mr. Murray's church, intended to be erected in Worcestershire (475), is characterised by that good taste which makes the best of the simplest materials, and bears out our previous remarks on his "Peterborough" design (451).

Chapels.—Though there is necessarily a degree of similarity between these buildings and the last mentioned, yet there is a sufficient difference to warrant a distinctive classification. It is evident, on comparing the many designs before us, that "Gothic" is quite in the ascendant here as elsewhere, and that dissent is no longer to be stigmatised as the religion of barns. For some time there has been a decided advance in the character of all chapel-buildings, stimulated by a like movement on the part of the Establishment, to whose structures not a few of these others are nearly assimilated. But, as dissenters, for the most part, repudiate symbolism in architecture, and can have no use for chancels or steeples; to be consistent, their buildings should be minus those features; although thus shorn, they are necessarily wanting in that dignity and variety of grouping which distinguish a well-designed church.

But while, as just stated, the favourite style is Gothic, we perceive in (73, 77) a Classic chapel of some pretensions, actually in course of erection. It is for the Baptist denomination at Hackney, and designed by Messrs. Habershon. It has a four-columned projecting portico, of the Roman-Doric order; continued by pilasters along and around the side walls. The pediment to the portico has a very ugly circular window (for what?) in the tympanum, and a second pediment rises immediately behind to close up the roof of the main building. The side windows are ranged between the pilasters in two heights, but are so contrived as to form one composition. The interior view promises well. The roof is of arched form, nearly semicircular, having at intervals ribs springing from corbels below the level of the wall-plate, thus giving a lunette vault over each of the window-heads,—a plan, it will be remembered, that Wren not unfrequently employed with good effect. In Messrs. Lander and Bedell's "Independent Chapel at Islington" (8, 10), we have Gothic, with a touch of the Venetian element; but, in search after novelties, many absurdities have crept into the design. For instance, what will our readers say to a tiny label-mould being brought down on to shafts apparently placed solely to receive it, yet actually more bulky than *it;* and they, in their turn, stuck forward on buttresses, added for the purpose? There is, however, considerable merit in the plan, considered as an *auditorium.* Its form is octagonal, with one side rectangularly prolonged; in connection with which are the approaches, staircases, &c. The roof springs from the side walls only, and consists of a series of half-principals, with curved ribs (cusped), but without tie-beams, and uniting at collar-level in an octagonal curb, from the centre of which depends a corona. There are galleries and two tiers of windows, the upper ones consisting throughout each of three spherical triangles enclosed by a circle. Externally the look of these is poor. Mr. Messenger's Congregational Chapel, about to be erected at Folkestone (15), is to all appearance a plain *church,* since it has tower and spire, and a kind of transept, used probably for a vestry. What would be the chancel-end does not show in the view. (206) by Mr. J. Brown, is small, but simple and good. The stone entrance-porch, corbelled out and gabled, reminds us of one of the domestic examples in the appendix to "Pugin." In (229) Mr. Kerr gives another specimen of "Ornamental Brickwork applied to a Chapel." The style adopted is a kind of mixed Italian, with the details worked almost entirely in brick. There is, of course, some ingenuity in preparing and fitting together the mouldings and various faces, but instead of imparting a distinctive character to the material thus used, the architect aims to follow closely the classical types of stone-work or compo, and the endeavour seems ill directed. No idea is given of comparative cost, but it is to be presumed that, in the opinion of Mr. Kerr at least, any expense is counterbalanced by its recommendations. We must protest against such an use of arch, impost, and attic, as this gentleman has combined to form a stack of chimneys to his Forest-Gate chapel, of which a whimsical sketch by moonlight is shown in (235). The Congregational Chapel, Kentish-town (271), by H. Hodge, has in execution some very coarse and objectionable features, which are less evident here. The style is late Perpendicular. A much better design is (305) for a Baptist chapel (T. Harris), or another (433), probably for the same competition, by Mr. T. D. Barry.

Schools.—The number of drawings of schools is almost equal to that of cemetery chapels, and like them too are mostly but of average merit. The first in the catalogue, and certainly one of the prettiest is (11), by Mr. Teulon. The outline is pleasingly varied, but the architect has over-honoured a stack of chimneys by making it the chief central feature. The next picture (12), "Schools erected at Folkestone," by Messenger and Keeble, shows likewise a capitally grouped building, in detail altogether quite plain. The "St. Mildred's National Schools, Canterbury" (14), by the same architect, are very tamely treated, and more regular in plan. From one so well versed in school building as Mr. Joseph Clarke, better things might have been expected than the School (35), as erected by him at Berkhampstead. The style is the worst kind of Elizabethan, and we regret to see that it is not the only specimen in the room. (39) Mr. Wither's competition design for Ludlow National Schools, is on the whole satisfactory—the two-story building especially; and far superior to (262), Mr. Pedley's design for the same, which is of red brick, rather awkward in shape, and with rather clumsy stepped gables. Mr. Lane's design for the "Central London District Schools" (59) would seem to rival in extent the building with which Hanwell is usually associated. In the almost interminable frontage before us there was great scope for comprehensive and effective grouping, such as we before adverted to in connection with Mr. Allen's barracks (hung very near), but it has been lost sight of; and the simple repetition, over and over again, of a very ordinary series of windows, though imparting a degree of grandeur, is a poor substitute. The "Grammar School at Felstead" (72), by Beadel, Son, and Chancellor, is a red brick Tudor structure, and very nicely treated. In the two views which Mr. H. Clutton exhibits (116, 117), are some excellent points, more particularly in the latter, which in its winding staircase, showing externally, and several other features, betokens a continental origin.

In (147) and (224), the two lines of buildings meet, forming an

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angle. The windows to the former run up into high-dormer-like gables, which they would have fitted better had there been one instead of two level lights for a centre. (224), by Messrs. Gabriel and Hirst, is altogether one of the best in the exhibition, without in minor details calling for special notice. We cannot say much for Messrs. Habershon's "Cluster of Schools" (168), which are of the most common-place kind. Is it from mere indifference, or that the school type of building is exhausted, when those who are most practised in the erection of such structures so seldom invest them with marks of originality? Even when peculiar opportunities offer, such as in the "Central London District Schools," just mentioned, and for which Mr. Phipson shows his design (173), the chance is again lost sight of. Here we have a most extensive pile of building, but in all that betokens architectural art absolutely wanting. On a much smaller scale, and very differently treated, are Messrs. Gabriel and Hirst's proposed "Parochial Schools and Residences at Keynsham" (188), which are really designed with much correct feeling. The style is Gothic,—plain, of dark material with light dressings, and in these respects not unusual; but the masses and forms are very pleasing, and show that they have been well considered. There is one feature to which, however, we must demur; and that is, the comprising a square three-light window by a pointed arch, into which it is set as a kind of panel. Independently of its unmeaningness, the lines become positively incongruous, and it interferes seriously with the repose and consistency of the design. This general consistency is better preserved in (231), "Design for the proposed National Schools at Horsington, near Wincanton," by H. Hall, which, though quite plain, are well proportioned and balanced. In this design, as well as in many others, not a little of the effect either for good or bad is owing to the management and grouping of the windows. In the present instance the lights are many, but narrow; some square-headed, and ranged in a varying series: the roof, too, is of good pitch, and has a small bell-turret.

Of "St. Michael's Schools, Wantage" (245, 246), we are at a loss how to speak. Knowing that their author, Mr. White, can draw, and has some pretensions to a cultivated taste, we must attribute to nothing but sheer affectation his sending out such drawings as these. Slightly sketched, and badly too,—washed over here and there with a sickly colour, their appearance is mean in the extreme; as wilfully slovenly as the design is forcedly quaint. In the description we are informed that the Institution is "for the education of twenty-eight maid-servants," and that the building materials are Cirencester stone with brick bands, the entrance and oratory with Bath stone dressings; roof covered with plain tiles; wood window frames, and herring-bone brick tympana. Another execrable drawing and still worse design, is (370), "Schools in course of erection (!) at Sandown, Isle of Wight," by J. Woodman, which have scarcely a redeeming quality. How long are such absurdities to be perpetrated, or such drawings to find a place in an Architectural exhibition, unless *in terrorem*? The "St. John's District Schools, Lewisham-road" (532), J. Peacock, appear a succession of low buildings, rather insufficiently lighted by chinks of windows. A very attenuated bell-turret rises from the side wall from a support formed by buttresses placed back to back;—a very sorry makeshift! The last design on our list is, happily, a commendable one. In the "South Metropolitan District Schools, erecting at Sutton, Kent" (534), Mr. Nash has evinced much sound taste and judgment, without any attempt at striking novelty. Advantage has been taken of the irregularities of the site in the general disposition of the ground, and we are glad to mention this fact, as it is one from neglect of which so many of our architectural buildings otherwise correct, are miserably tame and ineffective.

Almshouses.—There are perhaps fewer drawings of this class than usual, and these of no great pretensions. One of the best is (161) for "Sir Anthony Brown's Charity, South Weald, Essex," by Mr. Teulon, and forms a strikingly picturesque group, with an air of snugness and comfort. The site being a rising ground, the ridges of the dwellings are successively stepped to suit it; and this straightforward meeting of a difficulty, so far from being bad looking, is probably the best that could have been devised. A chapel is, as customary, the central feature, presenting its gable end and large window to the principal frontage, but without a doorway from the quadrangle, which it appears to want. Mr. Bright's competition design for Yeovil Almshouses (40), is of a character altogether *passé*. Mr. Lamarock's design (164) is not much better. The turret, in particular, is objectionable: it is attached to one angle of the chapel, and terminates in a very slender spire. (244) "Hospital for six aged women at Cambridge," R. R. Rowe, is another of those outrageously absurd things of which the less that is said the better. The chimneys are fussily heavy; but not more so than the gigantic statue perched as a terminal to the gable in the foreground. "The Master Boot and Shoe Makers' Institution at Mortlake" (383), J. Turner, presents a long frontage of Jacobœan work, founded on some well known old examples, and executed in its most suitable materials, red brick with white dressings; while Mr. Hodge's design (338) is on the whole of average merit.

To particularise every drawing not referred to in the preceding lists, but yet deserving of remark, would prolong this article beyond due limits; it will be necessary however to draw attention to a few.

Three conspicuous sepia drawings (1, 2, 3), illustrate Mr. R. W. Billing's alterations and additions to the Garrison Chapel, Edinburgh. These are very boldly treated in the Norman style, a great use being made of the corbelling system, which harmonises well with several Scotch features wisely introduced. Mr. Digby Wyatt's name occurs early in the catalogue, and his contributions are valuable and interesting. Perhaps the least so is (7), "Original Design for the Queen's Screen in the Crystal Palace." This, it will be remembered, is placed at the extreme end of the nave, and though richly ornamented, is in that kind of Renaissance which exhibits some of the worst phases of art. As specimens of ancient mural decoration for domestic purposes, Pompeii furnishes some of the best examples; and the drawing of "Studies made on the spot," by Mr. Wyatt (74), is exceedingly valuable. That these "studies" have not been in vain, is apparent in many practical works by the same hand; and a kindred feeling is shown in the finishings to the Paddington and Windsor stations, carried out in conjunction with I. K. Brunel, Esq. of which some portions are given in (79, 337). The bronze standard lamp in the latter drawing strikes us as particularly well managed. Among the most minute and beautiful drawings in the rooms may be mentioned the two (20, 99) by Mr. C. F. Kell. Both are well known views in Westminster Abbey, in which not only is the real effect preserved, but the detail carefully shown. Body colour has been very freely used throughout. The "Covered Homestead," by Messrs. Beadel, Son, and Chancellor (23), and the "View of Walls Court Farm," by Mr. G. Godwin (118), may be quoted as instances of architectural skill combined with plain practical utility.

In an artistic point of view there are few cleverer productions than those of Mr. W. Deane. Rather too dashy and careless, if anything, there is a power and intensity in the colouring which at once arrests and satisfies the eye. Each of his four pictures shows this facility of handling. While speaking of the artistic, let us at once include Mr. G. Aitchison's foreign sketches, and also those of Mr. Boutcher as most worthy companions. Mr. A. W. Blomfield also has two very excellent pictures of a kind which will maintain its utility until the marvellous powers of photography extend to colour also. (30) "Prior Bolton's Pew at St. Bartholomew's, Smithfield," is one of those barbarisms executed in the declining days of architecture, when it was allowable to block up a fine large Norman arch for the purpose of perching forward a genuine oriel window, forming a look-out from the comfortable lounging-pew behind. At one time such innovations were by no means uncommon, and in the church of our own St. Martin's-in-the-Fields is a like notable curiosity-sash, windows and all! (38) "Furze Hill Lodge, Surrey," designed by W. Young, shows a Palladian house in red and white brick, the dressings slightly projecting round the windows, &c., and a tinge of other coloured materials introduced here and there. Mr. Baker's "Sketch from Milan Cathedral" (41), and Mr. C. J. Richardson's "Interior of St. Peter's at Rome" (226), may be noticed as showing patient labour with but inadequate result.

Mr. D. Brandon has drawings, well designed and tinted, of several mansions, in what may be termed the old "correct" school, while others, like Mr. Chamberlain, venture out more freely. In (52, 187) we have geometrical drawings of a "House now erecting at Birmingham," of which the materials are red, white, and blue bricks, and the dressings of Bath stone. The tympana of all the window-heads have Minton's encaustic tiles in circular panels, with a band under a stringcourse, and a cornice in the same material. There is considerable elegance pervading the whole of this design and its chaste enrichments: it may be recollected that Mr. Chamberlain displayed last year some

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elegant detailed studies of a character similar to that here shown. One of the most finished drawings is Mr. Goodchild's "One Bay of the Interior of St. George's Hall, Liverpool" (53), showing the enrichments carried out from the designs of Prof. Cockerell. In this picture the proportions of the architectural "order" are clearly seen, also the position of the magnificent metal gates (a larger drawing of one of which was exhibited last year, and one of the elegant coronæ). In (60) Messrs. Ashpitel and Whichcord display a numerous array of "Works in hand or recently completed." (71) is a silver medal Academy-drawing of "Burlington House," carefully but not vigorously delineated. (78) and (103) are illustrative of Mr. I'Anson's "Designs for new Ceiling and Screen to Merchant Tailors' Hall." The former is an elaborately sketchy drawing, with an air of truthful effect. Although rich in detail, the architectural features appear questionable in point of consistency. Mr. Dwyer still pursues his favourite Renaissance fancies. Such a conception as the "Design for a Moulded and Vitrified Brick Mansion with Terra-cotta Enrichments" (82), would never commend itself to our good opinion. His other design (83) is more subdued, and therefore better looking. Mr. Petit, as heretofore, has some of his peculiar sketches, all distinguished by bold colouring and rapid execution. Most of them are continental, and evidently true to nature. In (250) he exhibits a clever view of the house now being erected for him at Bumblekyte, Staffordshire, by Mr. Thos. Hill, and of which another view and part of the section are exhibited by the architect (253, 254). It represents a plain red brick building, apparently quite a square block, of one story only, with a roof hipped all round, and in the centre of which rises a low square mass having a chimney stack at each angle. It has at least a decidedly novel effect, not wanting in character. Mr. C. Fowler, in his "Design for a Bridge at Westminster" (120, 121), proposes a roadway separated from the foot pavements by a series of pillars continued the whole length, and corresponding with others resting on the external wall; the pathway being roofed over and forming a terrace walk above. At each end towers are raised, and the whole has a prepossessing appearance. The sectional effect is very cleverly shown. Mr. Richardson's "Design for a Blind School" (148), is late Elizabethan in style, and rather tasteful. "A corner house, No. 38, Haymarket" (167), W. Roe, is Italian, badly proportioned throughout, and with meagre details. The "Villas about to be erected at Isleworth," by the same architect, are of a different character and much more satisfactory. (184) "The Asylum for Fatherless Children, at Stoat's Nest, Croydon," is one of Mr. W. B. Moffat's best efforts; the mass of building (which is large) being agreeably broken into picturesque combinations. Mr. G. F. Jones' "Design for the Cambridgeshire Lunatic Asylum" (202) is also deserving of praise. Mr. Truefitt has, on a large strainer, a collection of clever productions, the principal of which is a "Church about to be erected at Hulme, Manchester" (198). This is of very severe character, being entirely without projections or buttresses; even the steeple, which occupies one angle, has its walls flushed; the tracery of the windows is all sunk square and flush with the walls, there being no jamb-mouldings. The windows appear sadly too small and scattered; and will surely cause a gloomy effect inside. The spire is of slate, and quite plain till near the top, when it is encircled by projecting gablets. The "Entrance doors to Messrs. Brook's Bank" are well contrived, and enriched with an abundance of capital ironwork. (210) "Design for a Pulpit," C. F. Hayward, is an ingenious application of metal in the shape of a light scrolled railing with drapery behind, planted on an enriched base of woodwork. A little gilding is indicated, and the general effect is handsome and good. Mr. Cole's "View of King's College Chapel, Cambridge" (211), is unworthy of the subject. Labour is thrown away, and the picture little better than a smudge. In (216, 230, 336), Mr. S. Fisher submits his scheme for the "Decoration of a Church," which we must strongly condemn. It is quite a disputed point among the learned in architecture, to what extent colour is available as an adjunct,—whether, like the Sainte Chapelle at Paris, every portion of wall surface may be with impunity covered, or whether it should be confined to the occasional relief of monotony, and the picking out of specially choice and prominent features. In the former case, architectural truth is nullified, and materials, be they what they may, are wholly disguised; to say nothing of the glare of gaudy colour and consequent fatigue to the eye. Mr. Fisher seems, however, to approve of this plan, and covers his nave walls with a prevailing tone of green, using drab up to a certain height, and his chancel with a reddish hue, both surfaces being loaded with small patterns or diapers, which are repeated to a minute scale even on the mullions of the windows. The leading mouldings are shown as so many stripes of red, blue, or gold; the panel ceiling, of course, azure. That there is ancient authority for all this may perhaps be conceded, but the propriety of its reproduction is another thing. See also Mr. Colling's "Ufford Font Cover" (177). An example of colour on a small scale, restored from an ancient specimen, is shown in Mr. Dollman's careful drawing of the "Reredos at St. Cuthbert's Church, Wells." This gentleman has another first-rate drawing (223), in outline only,—of the "Interior of Westminster Hall," one of an intended series. (221) "Obituary Window and Reredos in Broadwater Church, Sussex," by Edward Hide, jun., has its fine old early English stonework filled in with perpendicular glass, not in itself very good; the Creed and Belief are placed above the Communion table; and the Commandments, painted on arabesque (!) panels are lower down and on each side of the table;—altogether very incorrect and unsatisfactory.

While on the subject of colour-decoration, we may as well advert to the admirable notions embodied in the many designs exhibited by Messrs. Galli and Cotti (273—291), which will repay examination, as also similar productions by Mr. C. Kuckuck. These show a great advance in a tasteful art, and one which must grow into favour. One great danger to be avoided is, lest genuine merit should take second rank to a showy and attractive garb; but form ought to be the first consideration, and then the fillings up. Mr. E. Morley has, on a screen (555), "Eleven Studies of Flowers, from Nature, for Decorative purposes," which are rather overdone in this respect, though much of the outlining is correct. Mr. Colling's "Spandrils designed from Natural Foliage" (293), and "Foliage designed from Nature," are much better; the second spandril, arranged on the triple principle; and the crocket being particularly good. Mr. W. P. Griffith's "Ecclesiastical Botany" (444), also contains some very good suggestions, well developed. So excellent a subject for the pencil as the "Strand Front of Somerset House," should be perseveringly studied, but Mr. Hue's "Geometric Elevation" is very badly drawn. Mr. Watson's Billiard-room at Berry Mead Priory (326) is noticeable as a piece of good colouring. This is more than can be said of the specimens of stained glass in which, as it appears to us, every exhibitor has more or less failed. (364) "Selections from the Architectural Publication Society's Illustrations, and from the 'Dictionary of Architecture,'" form a useful sheet, including the magnificent organ at Lubeck, a part of Milan Cathedral, and a curious specimen of Chinese domestic architecture. Mr. H. Horeau's "Frontispiece of Schemes and Sketches" (372), fully bear out the title. (391, 392) explanatory of "Mansions" erected on "The Cedars" estate, Putney, show a large site well and judiciously built on. Three "Designs for the New Town Hall, Hamburg," are exhibited; one by Mr. S. C. Fripp (424, 425, 426), another by Mr. Mitchell (537), and a lithograph of the one which gained the first premium, by Mr. G. G. Scott. Each of these is very differently treated, and the points of dissimilarity worthy of attention. The "Fleche at the Transept intersections of Amiens Cathedral" is detailed to a large scale by Mr. Burges in (446), showing completely its mode of construction. A fine series of photographs by Messrs. Bedford, Cundall, Sedgfield, and others, must not be lost sight of,—nor those to which photographic *colours* have been added (by Mr. Newman) as a further attempt in art. Some exquisite wood-cuts by Mr. Jewitt, from Mr. Street's 'Brick and Marble Architecture,' and by Mr. Branston, from Mr. Fergusson's Handbook (of which a notice will be found in another part of this number), serve to vary the objects of interest in these rooms.

Department of Materials, &c.

For the institution of this important adjunct to the Architectural Exhibition, artists, workmen, and visitors are alike indebted; and it is no wonder that its value is now so fully appreciated, that next year additional room must be provided for its convenient display. As yet it amply fills the allotted space, and two very attractive show-groups of metal work and church furniture find place among the pictures. The collection by Messrs. Hart, of Wych-street, is an extensive one, embracing ornamental metal finishings of every description, and it is, we understand, the same as recently exhibited at Paris. Messrs. Hart are too well known to require more than the mention of their

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name as a guarantee for good taste and workmanship. Mr. Frank Smith's "Church Furniture" is not on the whole over good: the large chair in particular is actually ugly, while a smaller one covered with stamped leather, and having a back of the same, is in the best of taste. A large collection of stoves and fire-grates has been supplied hy Mr. Pierce, of Jermyn-street, some of which evidence their practical capabilities with great success in the warming of the several apartments.

In the fourth room are some "Specimens of Consolidated Glass, in imitation of plain and inlaid Marbles," worthy of examination, as giving to ordinary glass the power of resisting blows, and being capable of rich coloured ornamentation. (3) "Specimens of Fire-clay Ware, or Artificial Stone," have the defect of other similar compo works, viz., that, in hardening, the arrises and mouldings cannot be preserved true. Mr. Wilshere's "Substitute for Paint by a preparation bringing out the natural Grain of the Wood," is an excellent invention, and far better than the thick muddy staining which has been too long in vogue.

An ingenious "Cistern Indicator" is shown by Mr. Alderson (7), which prevents any floating surface from getting into the down pipe, and also indicates the state as regards sediment. This is effected by means of an air-pipe rising to the top, and communicating with a dome which protects the opening of the down pipe. (8) is a model by Mr. H. H. Burnell, showing how the ordinary ceiling lath may be replaced by tiles, at but little more cost; and rendering the construction fire-proof. The tiles are proposed to be suspended by hooks from the joists, and are overlaid on the back with a thin coating of concrete. M. Remon's "Decorative Panels" (9) are not without merit, but less successful than some by M. Prignot (19). The "Models for (Spandrils of) Bookcases," designed by Mr. Colling, and executed by Messrs. Holland (12), are on the whole good: perhaps rather too studied and constrained. The general design has been adverted to in (395). Serpentine marble, as a beautiful material, and susceptible of great finish, is growing increasingly into favour; its charming colours and veining mark it out especially for choice enrichments. Several specimens are shown in (13). Bowden's "Ornamental Cut Glass" has too its recommendations. The pattern is clear and polished, chased out of a dead surface, and producing its effect by the contrast. See No. 14. "Tyerman's Patent Hoop Iron Bond" (10) is intended, at a small increased cost, to ensure additional security in tying or holding. This is effected by notching the iron at intervals of twelve inches on both sides alternately, and turning in succession in contrary directions a triangular piece, so as to form powerful reversed claws, which, once built in, become imbedded in the wall. The "Glass Mosaics" (18)—a panel inlaid in Bath stone—are worthy of notice as comparatively a new element (at least in England) in the highest description of decoration. Of an humbler kind is (26), "A New and Economical Building Material, applicable to all architectural and decorative purposes, made from the slags of iron-smelting furnaces." This, it seems, is an American invention, and one which deserves testing. We are not aware of any extensive use of it in this country hitherto. In (27) Mr. Greenwood, by vulcanised india-rubber inserted into a groove, patents a method of stopping draughts from doors and windows. An instructive lesson on the making and hanging of bells may be gained by examining Mr. Baker's models, in (28). Looker's "Hollow and Ventilating Bricks" are exhibited in (29). They may easily be arranged at the back of the fireplace, to form air-flues, which may be carried to any desired height, and to the right or left in the same or other rooms. By this means, part of the heat from the back of the smoke-flue, instead of escaping by the chimney, may be carried to any room, and be the means of giving warmth and ventilation to apartments not provided with a fireplace. Mr. Looker has also "Models of Patent Chimney Tops," which have slanting openings at their base, by which an upward current is produced; thus improving the draught, and preventing back-smoke. "Nibb's Patent Smoke Preventer" for the same end, is shown in (45). The specimens of leather ornaments exhibited (32) by Mr. Leake are excellent, combining a substantial effect of gorgeous colours with elegant taste. Such materials should be more frequently used. A most elaborate machine for putting together chimney-pieces is shown in (33), and described at length in the catalogue.

The fifth room is largely occupied with Pierce's stoves and grates, Botten's water closets, and Jennings' lavatories and drainage patents. A description of their several merits is next to impossible. As in most cases, an actual examination is necessary to properly understand them. Mr. Simpson exhibits some handsome mediævally-imitated paperhangings, and Messrs. Collmann and Davis a splendidly carved oak mantel-piece, in which metal work is introduced. The specimens of ridge tiles and crests by Mr. Brown, Surbiton (44), as far as materials go are excellent; his ideas for the Gothic crestings are by no means satisfactory. "The Patent Siliceous Stone Company" (Ransome's) exhibit several articles; as also does Mr. Cumberland, of Barrett's patent "Indurated Stone."

THE ARCHITECTURAL DIPLOMA.

SIR—Is architecture a scientific or an artistic profession, or a combination of both? Pray remember that this is the 19th century, and professions are no longer necessarily what they were in times bygone, when, for various reasons, those which are now divided between several individuals, were then centred in one.

I ask this, with reference to the request lately sent to the Institute of Architects by the students of the Architectural Association, begging the senior established architects to examine (first by courtesy, and then by compulsion) all who hereafter desire to become architects, and by granting or refusing them a diploma to pass judgment whether they be qualified or not to act in the profession they have chosen.

Now, if architecture is a science, this sought-for examination is well; but if it be an art, then surely it will be a false step—a step tending to confirm men in the trammels of copyism and of academical designing.

Is it a science?—Is profound scientific knowledge necessary to make a man an architect? If so, I would ask, what are the civil engineers? Are they not, so to speak, scientific architects,—are they not a body of men who, by their own exertions, and a just appreciation of the value of new materials, have, by a road entirely of their own making, carved their way to a deservedly high position as scientific constructors? Firmly established, then, as they are, shall the architects grapple with them and endeavour to wrest from them the laurels which they are evidently too well fitted to wear?—Surely not; such an attempt could but be a failure,—a failure which must take the worst effect on the public mind, showing, as it would, that architects are not what they pretend to be, and which must create a direct spirit of rivalry between the two professions.

Looking for a moment to professions other than those under our notice, we find that the physician, the surgeon, apothecary, dentist, oculist, &c., of the present day, were all formerly centred in the one profession of physician. The same, in its way, may be said to apply to the lawyer. Is it not, then, natural to infer that the profession of architecture may require division, for the same reasons that the others have before it, from increased resources and extended application of them suggested by modern requirements?

If my surmise be correct, then architecture is an *art*—as such, let the architects follow it up—let them do so with the same assiduity that the engineers have followed the branch they have adopted, and great results must surely follow.

But art is as *nil* till science be brought to bear upon it, and science has but little visible beauty till art be sent to its aid, to shape into comeliness that which science has formed naked and unsightly, with no object in view but pure utility.

The engineers are scientific men—let architects be artists; then, instead of the two professions becoming rivals, as they must do if the architects attempt to dismantle the engineers, let them unite their powers, each seeking counsel and assistance from the other: let the engineers contribute truth,—the architects, beauty, and hand-in-hand let them produce works worthy of the age they live in. No longer let the engineers erect hideous unartistic constructions, nor the architects false ones—piling, as they sometimes do, a *Greek* temple on the top of an *English* shop-front, without any apparent support than a few slight bars of metal and large sheets of crystal plate.

The time for shams is drawing to a close; the increasing education of the public demands that it should be so. Let architects, then, be what they pretend; but let them beware of engaging themselves with matters that can but be acknowledged to belong to another profession.

F. A.

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ON THE CONSTRUCTION OF ROOFS.

SPARS.

To make a Templet for the Spars of a Roof of a Building.

Draw A K half breadth of the building, and draw K G the king-post or rise of the roof at right angles to A K; join A G, and it will be the spar.

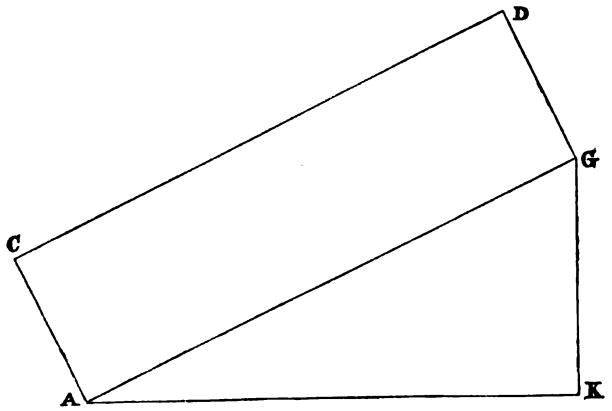


FIG. 1.

Draw G D at right angles to A G; draw A C parallel to G D, and C D to A G. Cut out the figure A C D G K A, and let the plane A C D G revolve upon the line A G, until it is at right angles to the plane A G K, and the two planes will form the Templet required. The lines G D and G K form the cut where the spar joins the roof-tree, and the lines C A and A K form the cut for the foot of the spar.

To Make Box-Templets for Scribing the Bevels of the Short Spars of a Building.

Fig. 2, the gable making a right angle with the front of the building; fig. 3, the gable making an acute angle; and fig. 4, the gable making an obtuse angle. In fig. 2, for C or C′ read C.

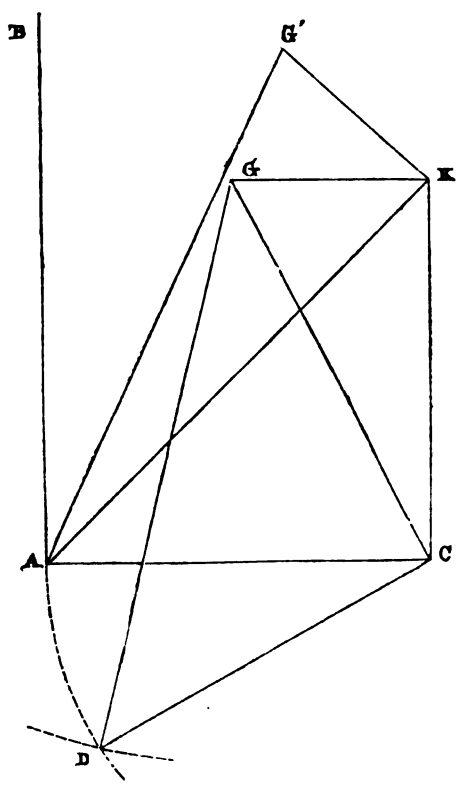


FIG. 2.

Let A B be the front of the building, A C the half breadth, A C′ half the gable.

Draw C′ K equal to A C, and parallel to A B; draw K G, the king-post or rise of the roof, at right angles to C′ K; join C′ G and it will be the length of the long spar.

FIG. 3.

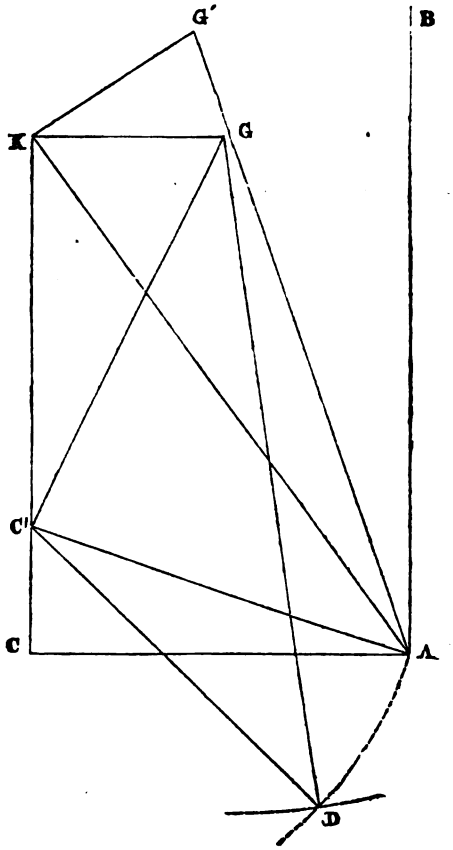
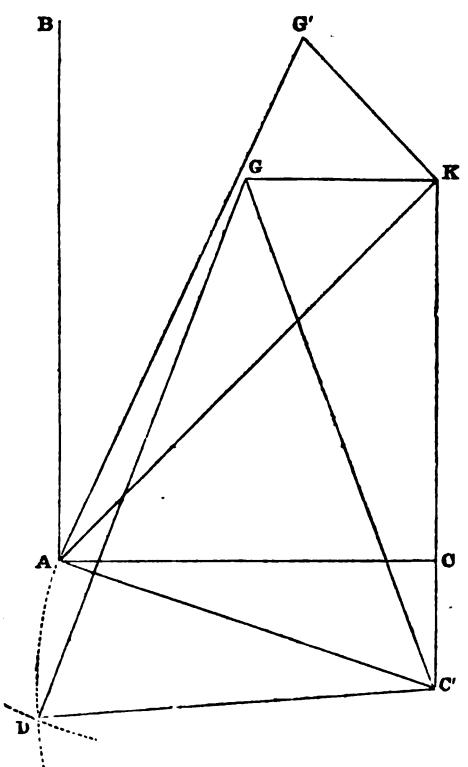


FIG. 4.



Join A K; Draw K G′ equal to K G, and at right angles to A K join A G′, and it will be the length of the rafter. With

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centre C′ and radius C′ A, and with centre G′ and radius G′ A, describe arcs intersecting each other in D. Join D C′ and D G. Cut out the figure K G D C′ K; let the plane D C′ G revolve on the line C′ G until it is at right angles to the plane C′ K G, and it will form the Box-templet required.

The lines D G and K G are for scribing the level where the spar fits the hip-rafter, and the line D C′ and C′ K forms the foot of the spar.

To make Box-Templets for the Short Spars for the Front and Back of a Building, the Gable not being at Right Angles to the Front.

Let A E B be the front, *a e* B′ the back, A *a* the gable, A C half breadth.

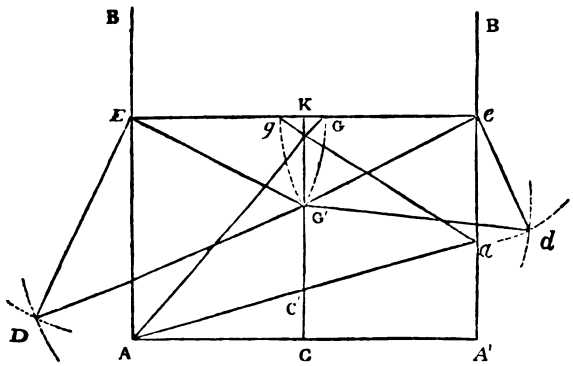


Fig. 5.

Draw C′ K parallel to A B and equal to A C; through K draw E K *e* at right angles to C′ K; draw K G′, the king-post, at right angles to E K; join E G′; with radius E G′ and centre E describe the arc cutting E *e* in G; join A G; with radius A G and centre G′, and with radius E A and centre E, describe arcs intersecting each other in D. Cut out the figure K E D G′ K; let the plane G′ K E revolve on the line E G′ until it is at right angles to the plane G′ E D, and the two planes will form the Templet.

Hip-Rafters.

To make a Templet for the Hip-Rafter of a Building of any pitch of Roof, the Gable making any angle with the Front.

Fig. 6, the gable making a right angle; fig. 7, an acute angle; fig. 8, an obtuse angle, with the front. In fig. 6, for C or C′ read C.

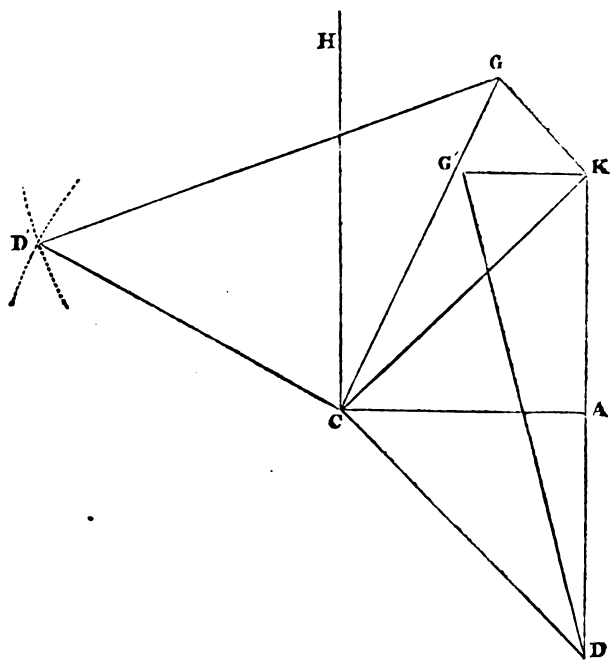
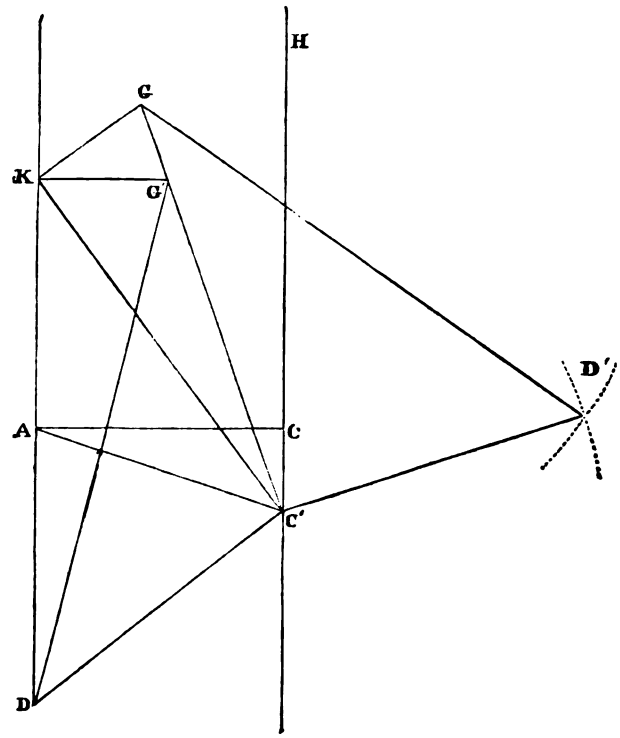


Fig. 6.

Let H C′ be the front, A C′ be the half of the gable, C A half the breadth of the building; draw A K at right angles and equal to A C; join C′ K; at right angles to K C′ draw C′ D, meeting the line K A D in D; draw the king-post K G′ at right angles to A K; join G′ D. Draw K G equal to K G′, and at right angles to C′ K join C′ G, and it will be the Hip-rafter.

Fig. 7.



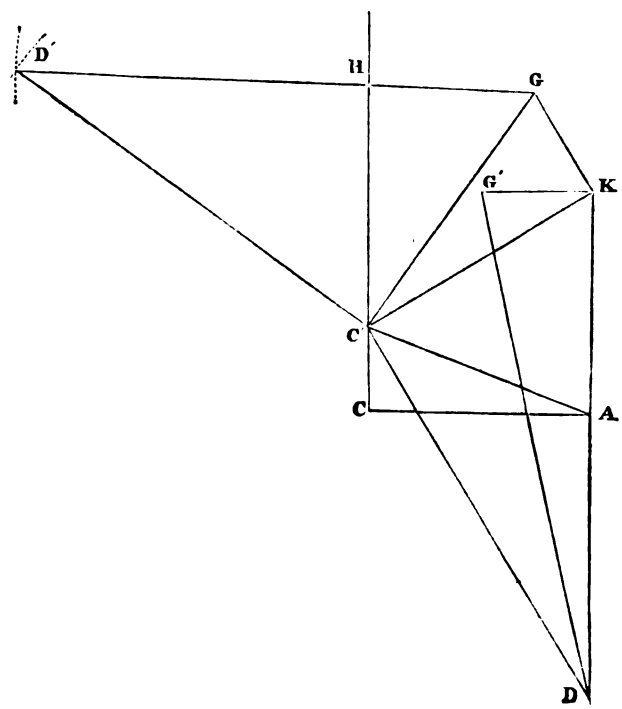


Fig. 8.

From C′ with radius C′ D, and from G with radius G′ D describe arcs intersecting each other at D′; join D′ G and D′ C′. Cut out the figure C′ K G D′ C′; let the plane C′ K G revolve on the line G C′ until it is at right angles to the plane C′ G D′ and it will form the required Templet, D′ G and G K being the lines for scribing the cut where the hip-rafter joins the roof-tree, and D′ C′ and C′ K being the lines for scribing the foot.

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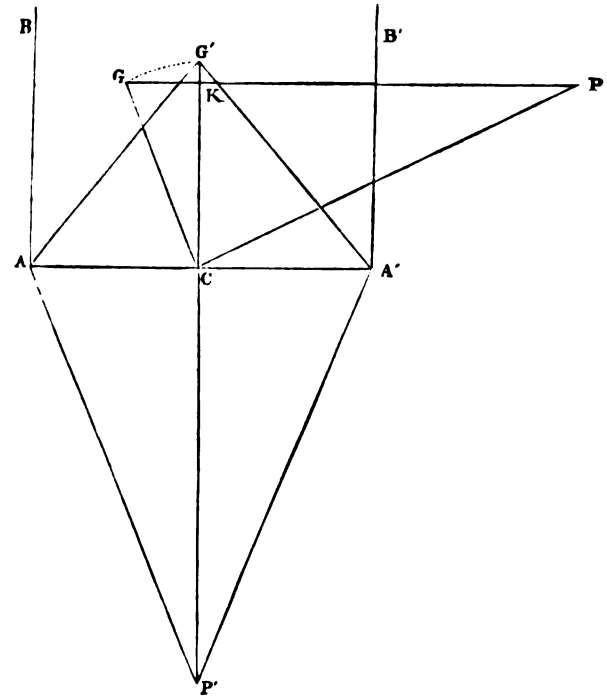
Ribs.

To Construct a Box-Templet for Scribing the Levels where the Rib joins the Hip-Rafter.

Fig. 9, the gable making a right angle with the front or back of the building; fig. 10, the gable making an isoceles and acute angle with the front and back of the building. In fig. 9, read C for C or C′ or C″.

Fig. 9.



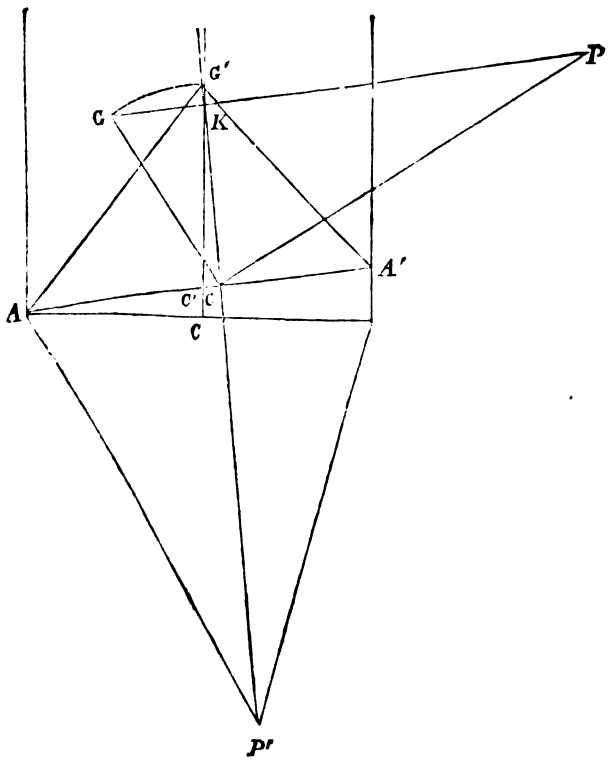


Fig. 10.

Let A B be the front, and A′ B′ the back of the building; A C half the breadth of the building, and A C′ half the gable.

From C′ with distance A C, and parallel to A B, draw C′ K; from K, let fall a perpendicular cutting A A′ in C″; draw the king-post K G at right angles to K C″; join G C″; at right angles to G C″ draw C″ P cutting G K produced in P; in K C″ P′ make C″ P′ equal to C″ P; produce C″ K to G′, making C″ G′ equal to C″ G; join A G′, also G′ A′, A′ P′ and P′ A′; cut out the figure A G′ A′ P′ A; let the plane A G′ A′ revolve on the line A A′ until it is at right angles to the planes A P′ A′, and the two planes will form the Templet.

When this templet is used, the plane A A′ G′ must be placed on the top side of the rib G′ pointing towards the roof-tree; G′ A′ and A′ P′ will join the right-hand rafter; G′ A and A P′ will fit the left-hand rafter.

If the planes revolve in a contrary direction, the bevels will be reversed. If sheet-iron templets be made for a common pitched building, having the gable at right angles to the front, they will be found to be very useful, as they will answer for a building of any breadth. In other descriptions of buildings, pasteboard templets may be made to answer.

Table *showing the proportions that the breadth of a building, half breadth, hip-rafter, spar, and king-post, bear to each other in a right angled building. Pitch of the roof 9 inch to the yard.*

	Breadth of building.	Half Breadth.	Hip-rafter.	Spar.	King-post.
Breadth of building	1·	·5	·75	·559	·25
Half breadth	2·	1·	1·5	1·118	·5
Hip-rafter	1·333	·66666	1·	·7453	·3333
Spar	1·7889	·89445	1·34168	1·	·4919
King-post	4·	2·	3·	2·236	1·

Example—1. If half the breadth of a building be 12 feet, what is the length of the spar and hip-rafter?

1·118 × 12 = 13·416 feet, the length of the spar.
1·5 × 12 = 18 feet, the length of the hip-rafter.

2. What is the length of the first, second, third, &c., gable-end spars, the first 15 inch from the corner of the building, the second 30 inch from the corner, the third 45 inch from the corner, &c., the gable being at right angles to the front of the building?

Half-length of building, 1; Spar, 1·118.
1·118 × 15 = 16·770 inches, length of first spar.
1·118 × 30 = 33·540 „ „ second spar
1·118 × 45 = 50·310 „ „ third spar

WIDTH OF STREETS AND ALLEYS IN THE METROPOLIS.

The Metropolitan Board of Works, at a Meeting on the 18th January, passed the following resolution:—

"That every street, excepting any mews, must be of the width of 40 feet at least; but if the buildings fronting any street be more than 40 feet high from the level of the street, then such streets must be of a width equal at least to the height of the buildings above such level. That every alley and every mews must be of the width of 20 feet at least, but if the buildings fronting any alley or to any mews be more than 20 feet high from the level of the alley or mews, then such alley or mews must be of a width equal at least to the height of the buildings above such level. And with regard to every such alley in reference to the entrance thereof, every alley must have two entrances thereto, each being at the least the full width of the alley, and one of the two at the least open from the ground upwards. And with regard to both such streets and alleys, the aforesaid width is to be ascertained by measuring (at right angles to the course thereof) from front to front of the buildings on each side of such street or alley. The word 'street' to include every square, circus, crescent, street, road, place, row, mews, lane, or place along which carriages can pass, or are intended to pass; and that whether there be or be not, in addition to the carriage-way, a footway paved or otherwise. The word 'alley' to include any court, alley, passage, or other public place which can be used as a footway only. If any person offend in respect to the conditions, regulations, and directions contained in this bye-law, he shall be liable for all the penalties and forfeitures imposed by the Metropolis Building Act, 1855, 18th and 19th of Victoria, chap. 122, in respect of any buildings either built contrary to the provisions of the said Act, or without due notice to the surveyor appointed in pursuance of that Act to inspect such buildings."

It was ordered that this resolution be communicated to all the district surveyors, to give it as much efficacy as possible.

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DRYING APPARATUS.

RICHARD POLKINHORN HUTHNANCE, Chipping Norton, *Patentee*, July 1855.

(*With an Engraving, Plate* IV.)

THIS invention consists in an improved mode of constructing a drying room and apparatus to be used therein, and an improved mode of constructing certain parts of the same.

Fig. 1 is an isometrical view of the drying room, with parts of the brickwork and one of the doors broken away, in order to show the apparatus and general arrangement.

Fig. 2, section of the two parallel plates into which the ends of the flue pipes are fixed next to the furnace.

Fig. 3, elevation of the front of the stove or furnace, to a larger scale, with sliding doors over, and perforated plate (shown dotted) at the back of the arch.

Fig. 4, longitudinal section of ditto.

Fig. 5, transverse section of ditto.

Fig. 6, perforated iron plate to receive ends of pipes.

Fig. 7, plan of hot plate and top of furnace.

Fig. 8, section through pipes and stone platform over, and elevation of support to the pipes in the centre.

References to Engraving.

A, the bottom grating of the furnace.
B, the double door to the furnace.
b', door to ash-pit, with the ventilator.
C, the flue or passage from the furnace to the pipes.
c', the boiler.
D, the hot plate.
d', *d''*, *d'''*, the three plates let into the hot plate.
E, stone over the flue.
F F', perforated plate to receive the ends of the pipes.
G, the arch over the hot plate.
H, the perforated plate at the back and over the hot plate.
h', the sliding flap over perforated plate.
h'', the rack, with guide rod over, attached to the sliding flap.
h''', wheel, ratched-rod, and pinion to work the rack for raising or lowering the sliding flap.
I, the iron pipes through which the flame and smoke pass.
J, the stone platform on iron bearers laid over the pipes.
K, the chimney or flue at the end of the drying room.
L, iron sliding doors with rollers.
M, iron frame and runners for doors to slide into, stregthened with iron quadrant or spandril corners.
N, the damper to regulate the draught.
n', iron bearers to carry the stone platform.
O, the centre support for the pipes in brick or stone.
P, the doors to drying room, one on each side of furnace.
p', ventilator at bottom of doors.
p'', slide in door.

At one end of the room the patentee constructs a stove or furnace with iron grating A, door B, and hot plate D; at the back of the furnace is a horizontal flue C, with fire bricks to convey the flame and smoke from the furnace to the iron pipes I (laid in a horizontal direction, or nearly so, and within a short distance from the floor) through the centre of the room, by which means the heat in the drying room is produced. Within and around the flue C, at the back of the stove is an iron boiler *c'*, for heating water, of the same form as the flue C, and so made that the flame and smoke can pass through the flue C, surrounded by the boiler, to the pipes I, at the back, by which means the water becomes heated; but this boiler *c'*, is omitted when hot-water is not required. The door to the furnace B, is constructed double, so as to economise the heat as well as preserve the door, and in order to regulate the draught of the furnace, a door *b'* is put to the ash-pit, and a sliding ventilator introduced therein.

The pipes I, are placed side by side and over each other, at a short distance from the floor; and in order to assist the draught, they are slightly inclined from the flue C, up to the chimney K. At a little distance above the pipes I, a platform of stone J, is laid upon longitudinal iron bearers *n'*, in order to protect from injury by the over-heating of the pipes I, the articles proposed to be dried. The pipes I, are supported in the centre by a brick or stone pier O, and the ends of the pipes shouldered and let into cast-iron plates F, F', perforated with holes to receive them; and the iron plate F, F', is built into the brickwork at the back of the furnace at one end of the pipes I, and into the chimney or flue K, at the other end. Another plate parallel to the first is added, which is placed a few inches apart from the first, into which the ends of the pipes I, are fixed next the furnace; between these two plates F, and F', clay, fire-clay, or concrete, is filled in around the pipes.

The stove or furnace is constructed in the following manner:—The bottom or grating A, is formed with loose cast-iron bars, let into an iron frame, and built in brickwork. The flue C, at the back of the furnace and next to the drying-room, is covered with stone E, and in the front of the furnace is fixed a double iron door and frame B. Over the top of the furnace is fixed a hot-plate D, with cast-iron frame, and three cast-iron flaps; the frame and each of the flaps are rebated and fitted together sufficiently loose to allow for the expansion of the metal, and, at the same time, close enough to prevent the smoke and flame from the furnace passing through the joints. This hot plate D, is intended to receive the flat-irons proposed to be heated in a room adjoining the drying-room, and to which the hot plate D is open, and an arch is thrown over the same in brickwork G. The furnace is to face this adjoining room, and at the back of the hot-plate is fitted vertically an iron plate H, perforated with holes, for the purpose of admitting the air heated over the hot-plate D, to pass through into the drying-room; and in order to regulate the quantity of air to be passed through the plate H, a vertical sliding flap *h'*, covers the inside next the drying-room, and is raised or lowered with a rack and pinion *h'''*, as may be required, and which, when closed, will prevent dust or smoke from entering the drying-room.

At the bottom and outside of the chimney or flue K, which is built at the end of the drying-room, and opposite to that where the furnace is built, two iron doors and frame are fixed, the upper door being provided for the convenience of sweeping the chimney, and the lower door for clearing away the soot. In the chimney or flue over the pipe an iron slide or damper N, to regulate the draught of the furnace, is fixed.

At the end of the drying-room in which the furnace is built, two doors P, are fixed, one on each side of the furnace, to communicate with the adjoining room; and in order to assist the ventilation, and to cause a draught through the drying-room, the lower part of each door *p'* is perforated and a slide *p''*, to regulate the draught, placed over the same.

The method of arranging the articles to be dried is on clothes-horses placed each side of the pipes, and on portable wood rails or lines, reaching across the drying-room from one horse to the other; and above the horses are placed wooden rails, which are continued across the room from wall to wall nearly up to the ceiling.

Claim.—1. The combination and arrangement of the drying-room and apparatus, as shown and described.

2. The arrangement and combination of the furnace and hot-plate, perforated plate, sliding-doors, with the boiler, as shown and described.

3. The arrangement and combination of the furnace and hot-plate, without the boiler C', as described.

4. The mode herein described of drying.

METROPOLITAN BUILDINGS ACT.

The attention of the City Commissioners of Sewers was drawn on the 22nd ult., to a report from Mr. G. Smith, one of the district surveyors, respecting the premises No. 3, Queen's Head-passage, Newgate-street, being in a dangerous state, the commissioners being empowered, under the Metropolitan Buildings Act, to act in such matters. The question arose whether the commissioners should appoint their own surveyor, or, as had heretofore been the custom, direct the district surveyor to attend to business of that character. After some discussion, it was agreed that the matter should be referred to the district surveyor, the commissioners deciding in accordance, as they conceived with the terms of the 79th section of the Act, which is as follows:—"Whenever it is made known to the commissioners hereinafter named that any structure (including in such expression any building, wall, or other structure, and anything affixed to or projecting from any building, wall, or other structure) is in a dangerous state, such commissioners shall require a survey of such structure to be made by the district surveyor, or by some other competent surveyor, and it shall also be the duty of the district surveyor to make known to the said commissioners any information he may receive with respect to any structure being in such state as aforesaid."

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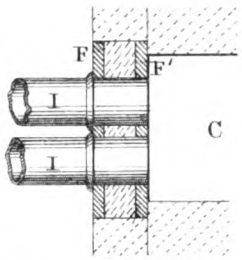
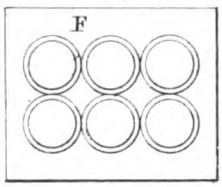
DRYING ROOM.

Fig. 2.

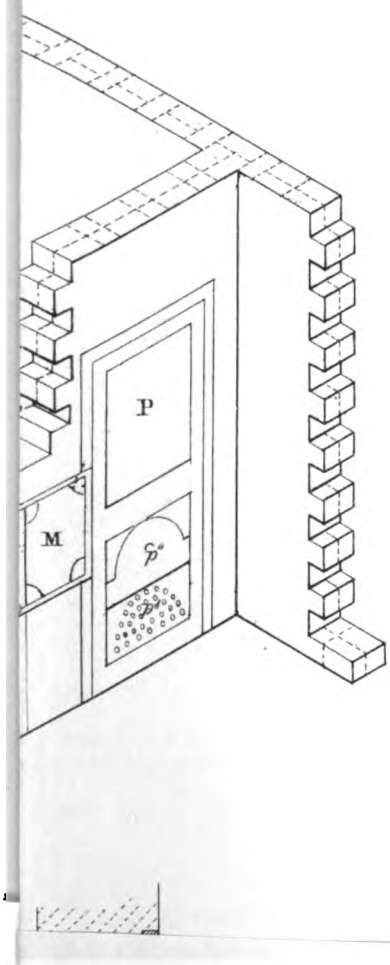


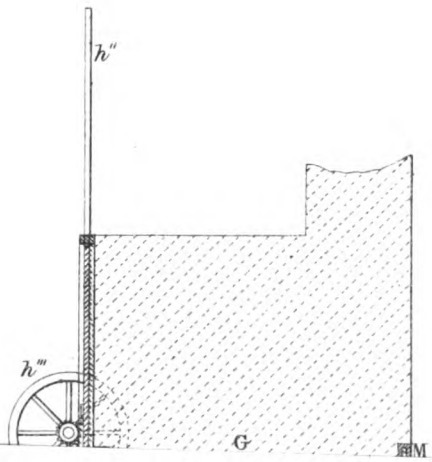
Section thro' Plates F & F'

Fig. 6.



Perforated Iron Plates to receive ends of Pipes





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ON THE POWER DISPLAYED BY CONDENSATION OF VAPOUR IN THE ATMOSPHERE.

By THOMAS HOPKINS.

It has been shown that solar heat is the source of the greater part of the force or power that is exhibited on the surface of our globe.* This power is displayed principally through the chemical union of heat with other substances, and its subsequent separation from them. By simple increase of temperature, heat enlarges both solids and fluids; and it greatly expands aeriform substances, as we see when the temperature of air or steam is raised; and in every such operation force or power is developed. But the power produced in this way, great as it is, is not so important to man as that which results from what may be called the molecular or chemical union of heat with other bodies. The chemical action of this imponderable substance seems to perform a highly important part in the living bodies of all organised *beings*, and probably gives to animals the physical force which they possess. But in inorganic matter the power displayed in chemical changes of the condition of heat is far greater; and among the different kinds of this matter, water seems to be of pre-eminent importance in its combinations with, and separation from, heat.

The combination and separation of heat and water give motion to ponderable matter on the surface of our globe, to such an extent as to warrant the assertion, that without their operations, the world in which we live would, comparatively, be an inert mass. To these changes we have to attribute the rain which *falls* on the earth, with all its influence on organised beings; and also the rivers which, after the earth has been watered, convey the product of that rain to the ocean, to be again and again raised into the atmosphere by heat. And the winds which occasionally display such great power, both on land and sea, are attributable to the same agency.

Few persons can have observed the action of a storm on a forest or on the ocean, without being struck by the power that was displayed by the wind. In a hurricane the strongest trees are often broken, and the ocean, over large extents of its surface, is frequently lashed by wind into a state that converts the naturally smooth sea into raging waves; yet all this power has its origin in the union of invisible solar heat, and water in the gentle process of evaporation. This process is known to take place over land as well as over the sea, and all must be aware that to it we are primarily indebted for the rain that fertilises the earth; but it is not often that the simple operation of evaporation of water is looked at as connected with the great movements of the atmosphere, and the power that is often exhibited in these movements on the surface of our planet.

The mechanism by which this power operates is the statical pressure of the atmosphere on both land and water, which amounts to about 15 lb. on every square inch of the surface. And when this body is put into motion it rubs the surface of land and water, or rolls over while pressing upon it, with the weight of the 15 lb. to an inch of the surface. The friction will of course be great even on a smooth part, but it will be materially increased by any roughness of the surface.

It is commonly considered that about three-fourths of the face of the globe are covered with water, but evaporation is not limited to that portion, as it takes place from land when it is moist, and sometimes more energetically than from water. The sun often raises the temperature of land more than that of water; and the more the temperature of moist substances is raised, the greater is the evaporation of water from them. This process is, therefore, sometimes more energetic on land than on water; and when, to an ordinary observer, the surface of the land appears to have been made dry, and is much heated, evaporation still proceeds until the water is extracted from a considerable depth in the earth. Even in dry deserts, where no rain falls, the surface being cold at night, is frequently moistened by dew, which is evaporated by the heat of the day. The process of evaporation of water may therefore be considered as taking place over the whole globe.

Evaporation converts the liquid water into aqueous vapour, an aeriform fluid. Its action is at first very energetic, and it is disposed to increase with an increase of temperature; but when the aeriform fluid has been produced, it presses on the surface of the liquid, and checks further evaporation, and the greater this pressure of the vapour, the more is the process of evaporation impeded, until at last it is stopped by the incumbent pressure. The amount of pressure of vapour required to stop the process depends however upon the temperature, it being small in low, and large in high temperatures; the atmosphere, therefore, in a cold country may be saturated with a small quantity of vapour, whilst it requires more to produce the same result in a warm one. But from the peculiar constitution of our compound atmosphere, condensation of the aqueous vapour which is diffused through it takes place in the higher parts, while evaporation remains active below; and the condensation above, by reducing vapour pressure, allows the evaporation to continue below with considerable energy.

There are, however, moist parts of the world where so much vapour is found in the lower parts of the atmosphere as nearly to stop evaporation, whilst other parts are found very dry, allowing the evaporation to take place with great energy; and, generally, this process takes place with various degrees of activity, dependent on the difference between the temperature and the point of condensation of the vapour, or the *dew-point* as it is called. When, therefore, the air is saturated, that is, when the dew-point and temperature are the same, there is no evaporation; with a rise of that temperature evaporation begins, and it increases with an increase of the temperature; and the more the temperature rises above the dew-point, the greater is the energy of evaporation.

Attempts have been made, with various degrees of success, to ascertain the amount of water evaporated by solar heat, and sent into the atmosphere in many localities, and it has been found to vary much in different parts, and to alter frequently in the same part with a change of temperature. In one part, near the Canary islands, off the African desert, the air has been found very dry, the dew-point being as much as 28° below the temperature; whilst in another part, not far distant over the rainy sea, the air has been nearly saturated with vapour. Evaporation from the surface of the sea must therefore have been very different in these two parts; and there is the same kind of difference in many other parts. But whatever be the quantity of water evaporated, in due time it returns to the earth in the shape of dew, rain, snow, or hail. And if the quantities of these could be ascertained, we should virtually know what quantity of water had been evaporated to form the vapour, the evaporation of water from the surface of the globe being, on an average, equal to the condensation of vapour. Certain portions only of the vapour are, however, returned to the earth in the form of dew, and as snow and hail, the greater part falling as rain. And it is well known that the quantities of rain that descend in different parts vary greatly. There are extensive regions where scarcely any rain falls, in others it descends in small quantities, and there are many parts where larger quantities fall, amounting in a few cases to as much as 300 inches in a year; in one place it is said to reach the enormous amount of 600 inches in the year. These differences in the quantities of rain falling in different parts, and the great fluctuations in the same parts, render it difficult to collect satisfactory data to establish a general average. But if that could be found, we should have not only a knowledge of the quantity of rain that falls, but also a good general idea of the magnitude of the evaporation which furnishes it. In the absence, however, of a knowledge of such an average, we may be permitted to assume one as an approximation to the truth, in order to have a case to reason upon, any one being at liberty to suppose that our assumption is either less or more than the facts warrant.

Dalton computes the average fall of rain for all England to be 33·3 inches. Leslie rates it at 30 inches. Schow calculates that the amount which falls north of the Alps is 26 inches, and south of them 37 inches; and he estimates the average of twelve places in the British islands to be 33 inches, of twenty-eight places on the continent of Europe above 40 inches, and nineteen places in other parts of the world about 73 inches. These statements are not given as an average of the whole earth, but they countenance a supposition that it may be as much as 24 inches.

The surface of the globe contains about 200,000,000 of square miles, and each mile contains 27,876,400 superficial feet. And if an average of 2 feet falls on the surface, we shall have on each square mile 45,752,800 cubic feet of water falling as rain in the year; and on the whole of the globe 200 millions of times that quantity, or 9,150,560,000,000,000 cubic feet. Now, from what has been already stated, it will be seen that the whole of this enormous quantity of water which falls as rain in the year, must

* See *Journal*, Vol. XVIII. (1855) p. 69.

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have been raised as aqueous vapour, by evaporation from the surface, before it was condensed in the atmosphere and converted into rain.

But the figures which express the whole quantity of water that falls on the globe are too many for the mind easily to grasp; let us, therefore, take a square mile, on which there falls in a year 45,752,800 feet of water, which, as we have seen, had been previously evaporated from the surface by heat, and endeavour to follow the changes that take place and the effects that are observable after the vapour has been produced. The whole of the vapour in going through the process of condensation in the atmosphere, liberates heat which exerts a power that disturbs the equilibrium of atmospheric pressure, and puts the atmosphere into motion. Evaporation takes up solar heat and makes it latent, and condensation gives it out and makes it active, the double process resembling that which is seen in the working of a steam-engine. The power displayed by a steam-engine is derived from the heat given out by the combustion of coal, which heat converts the liquid water into aqueous vapour or steam that expands with great force. But the solar heat raises vapour into the atmosphere, where it is condensed, gives out its heat, and swells and expands the atmospheric gases. In the former case, the heat powerfully expands water; in the latter, through the medium of water, it expands the atmospheric gases; but both the water and the gases are media through which heat acts.

A locomotive steam-engine is moved by a power derived from heat which has converted water into steam, and the quantity of water required to produce steam of a given temperature becomes a kind of measure of the amount of power furnished by the engine. This water has to be provided by railway proprietors, and they find from experience what is the requisite quantity. But special trials have been made to determine the quantity of water that is consumed by an engine of ordinary power, worked at the common temperature or pressure of steam. The Chevalier de Pambour, in his treatise on locomotive steam-engines, gives an account of some experiments which were made on the Liverpool and Manchester railway to ascertain this. The distance traversed on that railway was 29½ miles, and eleven journeys were made by six engines in 1834; the average load of the engine and tender was 48 tons 10 cwt., and the average time of the journey was 1 hour 52 minutes; the water consumed in producing the steam was a mean of 99·72 feet, but allowances have to be made for waste from different sources, which will reduce the quantity that furnishes the steam to the engine to about 50 cubic feet. Now each square mile of the surface of the globe, we have seen, furnishes 45,752,800 cubic feet of water in a year, which is enough to perform 915,056 such journeys. And the whole of the rain that falls on the globe in a year would be able to perform 183,011,200,000 journeys.

In the steam-engine, the water has to be vaporised by heat obtained from the combustion of coal, but the solar heat acts directly on the water of the globe. We see the source of the power of the engine, and can trace its working in the transport of heavy bodies. We may also form some idea of the aggregate effects produced by all the engines now in use, on land as well as on water. But how is the power used up by nature which is furnished by solar heat in vapourising water? Heat is equally united to water by evaporation in the steam-boiler and on the surface of the globe, and we see great results in the power given out in the one case by the engine; but what effects have been traced in the other? It is true we speak of the power of wind, but do not connect that power with the solar heat taken up in evaporation of water. On the contrary, that power is assumed to be derived from the direct solar rays; ignoring the influence of heat of evaporation, when given out by condensation of vapour. And this power, so papable in steam-engines, is never traced in the great operations of nature! It may, however, be permitted that we should attempt to trace it in some of its movements, to at least a sufficient extent to enable us to recognise its existence, though we may be unable to measure its extent.

Over the whole of the globe, the land as well as the water, aqueous vapour is passing from the surface into the atmosphere, where, by its elastic force, it expands into the higher regions, until it reaches an elevation sufficiently cold to condense it into liquid water. There is good reason to believe that from this height it would fall as comparatively mild rain, but for certain disturbances which take place in the atmosphere itself. These preliminary disturbances arise from known causes, such as the unequal power of the sun in different latitudes, and its varying influence on land and on water. These produce slight changes in the weight of different masses of the atmosphere occupying the same spaces, and cause them to move, though slowly, from one part of the surface of the earth to another; and when in their movements these masses encounter elevated land, they, by the force of their inertia, ascend it, passing into colder as well as higher regions, where condensation of vapour takes place more freely than it does at lower and warmer levels, whereby cloud is formed, and the heat taken up during evaporation is more freely liberated. The atmospheric gases are then expanded in these parts by the liberated heat and forced upwards,—on which, heavier gases below press towards and follow the lighter; and this being continued, a horizontal current, or a wind, is created. This disturbance of the atmosphere being continued, gives additional motion to air, which increases the amount of condensation over elevated land, liberates more heat, and produces more cloud and rain; and thus greater heights are reached, heavier rains produced, and stronger winds are made to blow towards the vacua that have been created. In this way condensation of aqueous vapour takes place more freely near to, and over, elevated land than over other parts, and portions of the atmosphere move from adjoining lower levels, or from the sea towards the land, carrying with them vapour which had risen from the surface of both sea and land. Thus the vapour which the solar-heat raises from the ocean is, to a large extent, borne to the land and condensed over the elevated parts of that land; and towards those parts air moves, conveying vapour, until at last heavy rains fall, and strong winds blow towards lofty mountains, which thus become important agents in producing great disturbances of the atmosphere.

In this way, the lofty Andes of South America to a great extent drain the basin of the tropical Atlantic of its vapour; and the East Indian Archipelago, and other Australasian islands, receive the vapour of the Pacific ocean. The Ghauts and Himalaya mountains are furnished with a large amount of the same material from the Indian ocean, more particularly when the sun is on the north side of the equator, the condensation of which material creates the south-west monsoon of these parts. The mountains of central Africa appear to receive partial supplies of vapour from the southern portion of the Indian ocean, and from the valley of the Nile, but they receive still more from the gulf of Guinea and adjoining parts of the tropical Atlantic. Towards these various elevations the vapour is borne by the winds, in the way that has been described, and on being condensed it creates such vacua as cause air to rush towards them with the various degrees of force and constancy that are experienced in the Atlantic tropical trade winds, the eastern winds of the Pacific, the monsoons of the Indian ocean, and the different winds that blow towards central Africa. These, in their progress over the ocean, create first slight ripples on its surface, then small and large waves, and at last, in the storms that occur in the latter parts of their courses, lash the water into mountain billows, which exhibit a sublime display of grandeur and power. This power however is all derived from the solar heat that had been previously taken up in the almost unobserved process of evaporation of water.

There are elevated lands outside of the tropics,—in the western countries of Europe,—along the western coast of north America,—and on the western side of the southern extremity of America, where the same kind of phenomena take place; in the two former parts when the sun is in the northern tropic, and in the last-named at all seasons, constituting them regions of rain and wind, and therefore localities in which the solar heat displays its great disturbing power. In addition to these mountainous regions, there are numerous elevations distributed over the earth, which, in condensing vapour, produce important effects, creating local ascending currents and consequent horizontal winds,—thus contributing to the production of that motion and change which are so generally found in the atmosphere.

But when, through the action of liberated heat of vapour, masses of air ascend in the atmospheric space, other masses must descend; and, the two operations continuing, they must produce, in no long time, ascending and descending movements in many parts. It has been said that air regularly ascends from the tropical and descends in the polar regions, but no such general movement can be traced in our atmosphere; and if any does take place, it can be only to a small extent. The air, however, which goes from any place in the lower part of the atmosphere into a

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partial vacuum, ceases to sustain the air that remains above that place, and permits that which had been above it to descend; and this operation being continued, that which ascends in one locality will in due time descend in another, at some distance, forming a kind of irregular circle or vertical wheel of ascending and descending currents of air, with intervening winds in both the lower and upper regions; or that which goes up in an ascending current, may come down perhaps at a great distance, and there feed another horizontal lower current,—for it is certain that wherever a partial vacuum in the aerial ocean causes adjoining air to move towards it, such air will be followed by other adjacent air that presses with the greatest force; and this may possibly have recently descended from the higher regions, or it may have come from a great distance, that which is cold and heavy being always ready to press towards the part where light heated air had ascended. And where there are irregular elevations of the land, the aerial currents in the lower regions will be liable, more or less, to interfere with each other, and, from change of season and other influences, may be diverted, modified, and altered, to indefinite extents. One of the currents may penetrate or force up another, producing new clouds and fresh partial ascents, creating altogether a complication of movements very difficult, if not impossible, to follow in detail. Still, notwithstanding all this complication, we may trace with sufficient clearness the principal areas of condensation of vapour, and infer the consequent ascending currents of air, as well as follow the main channels in the atmosphere, along which horizontal winds pass towards these areas, as pointed out in the different winds that have been named.

From the statements that have been made it will be seen that much condensation of vapour, great falls of rain, and ascending aerial currents, are to be found over many elevated lands. But there are also certain parts over the level sea where rain sometimes falls heavily. One of these, in the Atlantic ocean, a little to the north of the equator, has obtained the name of the rainy sea. The peculiar state of things, however, in this part, arises from contiguous winds beginning to blow, from the rainy locality, in opposite directions towards areas of condensation, leaving an intermediate space undisturbed through the equality of the forces which are in action on each side, until accumulated vapour saturates the air in the locality, and brings on rain. There are a number of parts over the sea which are subject to this kind of influence; but still the vapour which arises from the surface of the globe is, principally, condensed over mountains,—and horizontal currents of air flow towards those mountains, either over the low level of the ocean, or over low plains or valleys, and these currents constitute the great winds that blow over both sea and land.

The power displayed by the atmosphere, when in rapid motion, has been already glanced at, but it may be again adverted to. Much of the power must evidently be expended in friction while the air is passing over the surface, on which it presses with a weight of 15 lb. to the square inch. Yet, in rushing over land it displays great power, often levelling with the earth some of the strongest works of man. Over the whole of a country large trees are bent like reeds by the power of wind, or have their trunks broken like dried stalks of flax. In the great trade winds, this power is found to be exerted over immense extents of surface at the same time. In passing across the Atlantic from northern Africa to tropical America, a distance of not less than 3000 miles, a wind is found blowing over a breadth of, say 15° of latitude! The area of the trade wind of the southern Atlantic is still longer, and to it may be added, as forming the commencement of this great wind, an almost equal space between western Australia and southern Africa. Over large portions of the northern Indian ocean, the north-west monsoon blows in our winter; and in the summer, nearly the whole of the tropical part of that ocean, extending far to the south, is swept by the fierce south-west monsoon. In the great Pacific, a still larger area is traversed by the trade winds, which at their termini are often very strong. Over the waters of these wide oceans, the great force of wind is strikingly displayed; a very small portion of which is made available by man in impelling a few ships over the surface; the greater part being expended in ways which man has not been able to turn to his purposes, and therefore, has been but little noticed. In many parts of these immense spaces wind often shows its wonderful power. Few things make man more conscious of his weakness than exposure to a tropical hurricane on land; he bends to its irresistible force, happy if he can escape destruction. But it is on the agitated surface of the ocean that that force is principally exhibited, and here it may be witnessed in its awful power and grandeur! Whoever has seen the water of a wide ocean lashed by a fierce tropical storm into mountain waves, will admit that it presents an exhibition of sublimity not to be paralleled in any other department of nature. And when it is recollected that the portion of the raging ocean which is at any one time within view, is but a small part of the whole that is in equally violent commotion, the mind, unable to comprehend the magnitude of the power exhibited, is overwhelmed with the contemplation.

But this is not all the power that is displayed by wind on the ocean, for it not only raises waves, but forces forward the whole body of water on which it presses. Over immense extents of the ocean, currents of water are created by wind. From the tropical towards the polar, and from the polar to the tropical regions, from the east and from the west, winds blow, and put in motion oceanic currents. One of these takes its departure from north-western Australia, traverses the southern Indian ocean, passes round the Cape of Good Hope, and crosses the southern Atlantic, when it joins another of almost equal magnitude from Madeira; and the united body of water passes into the gulf of Mexico, the surface of which is said to be raised 350 feet above the natural oceanic level; and all this is accomplished by the continued force of wind. The statical pressure of this elevated water forces a large ocean stream through the straits of Florida, along the coast of North America, and across the Atlantic by the Azores to Africa. In the great Pacific ocean we see, in like manner, the wind in the eastern part of that ocean put the whole water of the tropical surface into motion, impelling it westward excepting when disturbed by islands, until it reaches the East Indian Archipelago and the groups of islands lying north and south of it, among which very strong currents are found. And thus we find that the solar heat, operating through the almost unobserved process of evaporation of water, puts in motion not only the atmosphere, but the great waves and currents of the ocean, and gives to them the enormous aggregate power which they display in the various ways that have been named.

That wind is the power that puts in motion these large oceanic currents is sufficiently evident. Wind always accompanies the primary movement of the water. In many parts the winds change with various degrees of irregularity, and the movements of the water change with them. This is admitted to be true of waves which are known to be always primarily produced by wind; but it is clear that ocean currents are created by the same agency. In certain parts the winds change periodically, and the ocean currents change with them. In other parts the winds are non-periodic, and then the currents are also non-periodic, evidently obeying the action of the wind. The pressure of 15 lb. on each square inch of the surface, while the air is in motion, is found capable of producing all the movements that have been named, whether as elevation in waves or when impelled forward as a current, the kind of current being dependent on the strength and continuity of the wind.

We perceive, then, that the force which puts in motion the waters of the ocean has its origin principally over land. It is over elevated lands and near to ridges of mountains that the solar heat which is taken up by evaporation of water, is liberated, where it expands the gases of the atmosphere in such way as creates partial vacua and produces winds, and gives to them the force which they exhibit: and from these mountains the influence of the vacua may be traced in the principal winds that blow over the surface of the globe.

One of the most conspicuous areas of condensation with which we are acquainted is on the eastern side of the cordillera of the Andes,—and as the Amazon is the river that receives the largest amount of the water which there falls as rain, we may call this the Amazonian area of condensation. Towards this area winds blow from far-distant Australia in the southern and Madeira in the northern hemisphere, conveying vapour that furnishes the material of the rain, and which creates the vacuum. These winds are partially disturbed by the island of Madagascar, the Cape of Good Hope, and to a small extent by the island of St. Helena, in the southern Atlantic, and in a larger degree by the mountains of Brazil and Guiana, in all of which places rain falls more or less freely; but the main broad stream of the moist atmosphere reaches the eastern side of the Andes, where it has the greater part of its vapour condensed; and then the gases, being heated, are rendered light, and are forced by gases both colder and heavier into the higher regions of the atmosphere.

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The next great area of condensation of vapour that may be pointed out, is that which is found on the western side of the tropical Pacific ocean, near the East Indian Archipelago, the Philippine islands to the north of the equator, and the new Hebrides, Feejee, and Friendly islands, to the south of it. Towards this large area winds blow over the wide Pacific, taking an abundance of vapour with them, the condensation of which is effected near to and among these islands. This may be called the Australasian area of condensation, there being no great river receiving the water furnished by the rain in this part.

The third area, in point of magnitude, is that which is found in Hindoostan, including the Neilgerries and Ghauts in the south western part, and the Himalayan range in the north of India. To feed this area with vapour, winds blow in the summer from the south, extending over a great part of the tropical Indian ocean, furnishing the rain water which flows down the smaller southern rivers, and also down the Indus, the Ganges, and the Burrampooter, as well as the large Chinese rivers. On account of the large body of water that descends from the Himalaya range of mountains, this may called the Himalayan area of condensation.

The above-named may be considered the three great areas of condensation of atmospheric vapour on the earth, where vacua give birth to winds that have such palpable characters as to obtain for them specific names. They are all more or less disturbed by the passage of the sun across the tropics. When he is in the southern hemisphere, those parts that are south of the equator are supplied with a greater abundance of vapour, and receive a larger amount of rain; and when he passes into the northern tropic, the northern parts are more abundantly supplied. The Himalayan range, being north of the equator, receives its principal supply when the sun is in the northern hemisphere, as do also the West Indian islands, the countries near the gulf of Mexico, and the Philippine islands, they being all north of the equator.

The south-western extremity of South America has been already pointed out, but there are other places in the south at a distance from the equator which are palpable areas of condensation, such as Van Diemen's land, New Zealand, and various other islands, all of which have their influence in producing rain, and creating vacua which give birth to atmospheric movements. There are also many elevated parts outside of the tropic, in the northern hemisphere, which by condensing vapour originate winds; such as those along the western coast of North America, up to the latitude of 60°, and of Europe up to Lapland and Nova Zembla, with others in various parts of both continents. These, by creating atmospheric vacua, all give birth to winds in which air passes from where it is heavy to where it is light, within smaller or larger distances.

These direct effects of vacua on adjoining air take place in the lower regions of the atmosphere, but they are sometimes blended with the more immediate results of the expansion of air by the heat of condensation. It has already been shown that heated air ascends in some parts, and that it must descend in other parts, to re-establish the equilibrium of atmospheric pressure; but ascended air appears to be sometimes brought down to the surface by rain, and it often descends at such an angle as to be projected along the surface in a horizontal direction, until the force of the falling rain which put it in motion is expended: and wherever rain falls heavily it must always have more or less of this effect. In such way some of the horizontal currents appear to be partially fed, like the south-west wind which starts from the West Indies. But, instead of the descended wind ceasing as soon as the impulse given by the rain ceases, this current flows on to feed the vacua produced by the various areas of condensation which exist in the western part of Europe. In like manner, the rain and snow which fall in Norway, Lapland, and Nova Zembla, may in their descent bear with them air which afterwards traverses the old continent until it reaches the mountainous regions of condensation in the south. The winter rains and snow of the north-western parts of America, may also in their descent take with them air which may pass from the north over the centre of that continent towards the gulf of Mexico and the West Indies.

Condensation of vapour, where it takes place abundantly, must evidently cause the air with which it is intermixed to boil up, and would make it all ascend to higher regions, but the water produced by the condensation, in its descent has a tendency to bring some of the air down with it. The two forces indeed frequently act antagonistically to each other, producing a large amount of turmoil and apparent confusion. Sometimes the rain reaches the earth before the air near the surface has been put fully in motion, and then the rain is said to bring the wind. This may often be seen at sea, at the same time, the rain descending in one place at one angle, and in another place at another, a local wind following each local shower, until the temporary force of the descending rain is expended. Sailors are quite familiar with such facts, and speak of having a breeze—a puff—or a capfull of wind, which soon dies away. And while these movements are taking place in the lower air, fresh clouds appearing in the sky show that local condensation must by its action be disturbing the higher regions, producing altogether complications which confuse and baffle sailors as well as other meteorological observers.

Thus we see that whether we have puffs of wind, or gentle zephyrs, sudden storms, or long continued winds, all are produced by the same cause, operating with various degrees of force and under different circumstances. It is the same solar heat that produces directly or indirectly all palpable winds, including those which lash the sea into liquid mountains, and those which create oceanic currents that traverse the globe. Heat from the combustion of fuel, furnishes the power given out by a steam-engine; and the heat derived from the sun gives all the power which comes from the condensation of atmospheric steam or vapour. The machinery of the steam-engine we can easily trace, because the parts are all under our observation; but that which is worked by solar heat is of such magnitude, the material is so impalpable, and the processes are so complicated, as to make it difficult to follow even in its principal movements, whilst in its details the labour is much greater. Patient inquiry, however, may do much! The moving power being known, its action may be studied, and the more important effects be noted: first, in its larger operations, where comparative simplicity exists, and then in its smaller, until the details become more palpable. But it is suggested, that in order to increase our knowledge in this department, *the laws* that are in action should be studied! Mere facts, however numerous, or carefully tabulated, do not necessarily increase our knowledge of principles; and in meteorology, the stock of facts already accumulated is alarming, rather than encouraging, to the student. Attention at present appears to be too exclusively directed to the registration of facts, to the neglect of inquiry into the laws that pervade them; and it therefore becomes desirable that those laws should be studied and discussed.

ROUTE TO THE PACIFIC.

We learn from the San Antonio *Texan* that on the 6th Dec., Lieutenant Parke, of the United States Topographical Engineers, with his surveying party, arrived in that city from the west, by the El Paso road. The party consisted of Lieutenant John G. Parke, United States Topographical Engineers, commanding; A. H. Campbell, C.E.; N. H. Hutton, H. Custar, assistants; G. G. Garner, astronomer; Dr. Antisell, physician and geologist.

This party has been in the field actively engaged since Nov. 22, 1854. From that date till the close of May last they were engaged in California. On the 26th of May they left San Diego and reached the Rio Grande at Fort Fillmore on the 6th of August, having spent most of the interval in the examination of that extensive and almost desert country which borders the Gila.

In an agricultural view it may be called a desert; for excepting the land on the Gila bank at the Pimas villages, the valley of the San Pedro, and a few scattered and isolated patches occurring about the large springs of water, the road for more than 300 miles is over an elevated table-land of unmitigated sterility.

Lieut. Parke was the first of the surveying officers in the field, under the grant made by the last congress for the purpose of finishing the surveys necessary to complete the various lines for the Pacific railway, and reporting to congress the result of his labours. He was directed to examine for a suitable road in Southern California, from Mastery bay to Los Angelos, and between the coast range of mountains and the Sierra Nevada. As the parallel of 32° east of the last mentioned mountains had been to a great extent surveyed previously by Lieut. Williamson, Mr. Parke was not required to repeat an examination, but was directed to examine certain points on the line between the Pimas villages and the Rio Grande, the result of which has been

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the exploration of the San Pedro river, and a more thorough examination and reconnoissance of the country immediately south of the Gila, and included in the "Gadsden purchase." Here, as well as in California, many new topographical discoveries have been ascertained, and as far as a railway along this route is concerned, the information as obtained may be considered complete and conclusive; and, in fact, proves that the line examined (near parallel 31°) is the shortest and easiest route to California, requiring no tunnelling, there being no steep ascents, and goods can be carried over the whole route; and by avoiding Tuscan and striking for the Gila, which receives the San Pedro, the long and dreaded jornada of ninety miles may be avoided. Even as a wagon and emigrant route this new one proposed and travelled by Lieut. Parke in this expedition will save distance and fatigue to animals, as more grass and water is to be had than by the "commission boundary" route, or on "Colonel Cook's trail."

By proceeding almost due west from Cook's Springs, by Ojo de Vaca, a series of valleys running north and south is reached, bounded by short ranges which can be travelled round, these valleys locking round into each other, and tending north-west to the Gila river, which may be struck where the fertile little valley of the San Pedro (the Rio Chiquito or the Apaches) meets that river; in this course every mountain range is avoided, and a country tolerably well supplied with gramma-grass is travelled over.

By adopting this as the railway route, all tunnelling might be avoided by adopting the precautions necessary to supply large trains. Farther south than this is the desert country of Tucson; and the elevated land of the Guadalupe Canon; and north of the Gila is a mountainous and sterile tract; so that nature has here provided a belt of land and almost as level as a prairie for the iron horse. When this is contrasted with the other routes, its advantages are at once apparent. Thus selecting three of the most practicable routes, viz.:

1. That of the 41st parallel, or the Mormon route, which runs from the Platte river over the plains to the South Pass, thence to Salt Lake, thence across the Great Basin to the Sierra Nevada, and into California by Sacremento river to Benicia.

2. That of the 35th parallel, or Rusk's route, which passes from Fort Smith to Abuquerque on the Rio Grande, thence across the Rocky mountains, the Colorado river and desert, and the southern end of the Sierra Nevada to Los Angelos and San Pedro in California.

3. That near the 32nd parallel, or Lieut. Parke's route, the extreme southern one, via San Antonio, New Mexico, the Gadsden purchase, near the Gila, over the Colorado desert and across the southern extremity of the coast Cordilleras to San Diego, California.

We will now give the length of the three routes in miles, and also the comparative cost:—

	No. 1.	No. 2.	No. 3.
Length of route.....	2032	1892	1618
Length of level route ...	2583	2816	2239
Comparative cost ...	$116,095,000	169,310,265	68,970,000

From these figures the advantages of the Texas route is apparent. It is almost one-third shorter than any other route between the Mississippi and the Pacific, it goes by a country where the rocky mountains drop down, and are only represented by elevated mesa land, and it strikes California where its two ranges of mountain chains have coalesced into one, and consequently where less hill-labour is encountered.

The route lays over elevated land, requiring but little grading, and over a country where winter snow rarely falls—and never accumulates. On the routes farther north, the rocky mountains present a barrier requiring extensive grades and tunnellings, and where winter travel is liable to be obstructed.

If this route be carried from El Paso into Arkansas, via Fulton, as is contemplated in the calculations made in the report of the Secretary of War, published a few months ago, a tract of land without water has to be passed over. To obviate this difficulty is the occupation of Capt. Pope, in endeavouring to form artesian wells on the Llanos Estacados of New Mexico. The success of this experiment is very doubtful, and hence the route through Texas, via San Antonio, is the one which is equally short, and has more advantages.

EXPERIMENTS TO ASCERTAIN THE EFFECTS OF GRADES AND CURVATURE ON RAILWAYS.

By Alfred Sears, C.E., U.S.

So long as the clay in which we are moulded is of grosser fabric than the mind, so long as the hand is harder than the brain, just so long will machinery of all sorts fall in its practical application below the standard of duty marked out for it by the formulæ of the philosopher. When we have ceased our labours to elevate man, we may withhold our efforts to perfect his work.

Hence, then, till a result is accomplished, that shall render experience unnecessary, experience will be interesting and valuable. If the result obtained from data furnished by properly conducted experiments be found to modify accepted doctrines—they aid in bringing formulæ into practical shape, and thus too they produce a still nearer approach to *perfectness of adaptation* in the machine to which they apply.

Of especial importance are the recent experiments on the New York and Erie railroad. In the subjects they reach, they are more extensive, in the influence they must exert more considerable, and in the effects, measured by a financial scale, as valuable as any other class of data that can be gathered from railroad practice. They yield truths to be regarded by the constructing engineer, and convey important suggestions to those having charge of the working of railroads—while they are also of interest to the locomotive machinist.

The object in view, at present, is to introduce the result obtained, more especially to the notice of the civil engineer and railroad superintendent. They will give additional data for the calculation of the much vexed question "of the equation of distances," an important problem in engineering, and one that has been subject to much confusion. As to gradients, the cause of the difficulty is, that many eminent men, who should have known better, have confounded the *angle of repose* with the *angle of double resistance*.

The latter cannot be a constant quantity, but is governed by the circumstances of the load and its portage. The *angle of repose*, on the contrary, may for practical purposes be assumed as constant, 0° 09′ according with the latest experiments. This angle produces an inclination of which the rise is ·258 of the length of the plane, equivalent to a grade of 13·7 feet in a mile—or referred to resistance to motion, is equal to a friction of 5·8 lb. per ton.

This supposes the plainest case, being that of a car on a track without joints, and moving with a velocity indefinitely slow, a case in which atmospheric resistance amounts to practically nothing, the motion indicating only that friction is balanced. The amount of power used to produce this result is called the friction of the train. It expresses, however, but the friction of the cars of the train.

A comprehensive thought will at once convince the engineer of the fallacy in that equation by which this simple element is made the only resistance encountered or worth estimating.

The *angle of double resistance* varies with the load—the style of the engine—the velocity. Other causes affect it, but these are the principal, and are always present. Hence, in estimating the value of different lines, it is important to consider the kind of business to be accommodated; whether chiefly a passenger or freight traffic; light trains at high rates of speed, or heavy trains at less velocities.

This paper will present those results only that are founded on reliable data. It will, therefore, be necessary to avoid all consideration of works accomplished by extraordinary methods, and expedient to omit notice of those miles that are of such mixed construction in grade and alignment as to compel calculations on short sections with the use of *averages*—a dangerous element in such problems.

Those situations of the trains on descending grades, in which the breaks were locked, are of course incidental to all railway locomotion, but form no part of the phenomena to be now considered.

The organisation of the trial train was completed on Monday, August 27. Operations began on Tuesday. The train left Dunkirk, the western terminus of the New York and Erie railroad, at as early an hour as the state of the track would permit; a dry rail being necessary to a fair exhibit of the adhesive power of the engine.

The engine No. 210 was appointed to the performance of these duties.

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Weight of engine	66,000 lb.
Weight of engine on drivers	40,000 lb.
Diameter of blast orifice	2½ in.
Diameter of cylinder	1,417 ft.
Diameter of driving wheels (coupled)	5 ft.
Length of stroke of piston	2 ft.

These figures are necessary elements in the calculations incidental to the experiment.

The formulæ made use of are those of De Pambour; and I have adopted the practical co-efficients determined by his experiments, when they have not been expressly ascertained for this purpose.

The experiments were made with heavy trains, the composition of which was regulated by the "ruling grade" of the various divisions of the road. These trains weighed, on different occasions of the trip, including engine, tender, and caboose, as follows, viz.—train designated for convenience

No. 1, composed of	25 cars	982,140 lb.
No. 2,	30 „	1,145,790
No. 3,	100 „	3,545,390
Weight of tender, roadworthy		42,240

The width of the Erie railroad gauge is 6 feet.

To illustrate what has been said concerning "Equating for Grades," it will be interesting to estimate the amount of resistances to be overcome with some of these different loads before they can be moved on the track.

1. The atmospheric pressure of 14·7 lb. an inch on each piston of which the area is 227 inches, may be reckoned as $2 \times 227 \times 14{\cdot}7 = 6674$ lb. But as the power of the engine is directed to the circumference of the drivers, it will be necessary to find the value of this element of resistance at the same point, to establish a relation between them as well as between this and the other resistances. The pistons travel two strokes measuring 4 feet, while the wheels make one revolution during which they have passed through 15·71 feet. Hence the proportion

$$15{\cdot}71 : 4 = 6674 : x = 1699 \text{ lb.}$$

2. The back pressure resulting from the construction of the blast orifice, and which depends on the velocity of the engine, may be represented when referred to the periphery of the driver by

$$\frac{4 \times 454\,p}{15{\cdot}7} = 116\,p,$$

in which p = back pressure in pounds per square inch. Hence then—

$$1699 + 116\,p =$$

the resistance in pounds arising from atmospheric pressure on the pistons and the action of the blast pipe.

3. Let T = number of tons (gross) composing the load including tender, and f = friction of load, being the number of pounds required to move one ton upon the track; in this case 5·7 lb. Then

$$f\,\mathrm{T} =$$

resistance opposed by the friction of the load.

4. Let g = effect of gravity in pounds per ton, and W = weight of engine in tons gross, then

$$g\,(\mathrm{T} + \mathrm{W}) =$$

the effect in pounds produced by the gravity of the train; to be added to or deducted from the other resistances, as the grade is ascending or descending. Then

$$f.\,\mathrm{T} \pm g\,(\mathrm{T} + \mathrm{W}), \text{ or } \mathrm{T}\,(f \pm g) \pm g\,\mathrm{W} =$$

the resistances opposed by the friction of the load and the gravity of the train.

5. We come now to estimate the resistance occasioned by the air through which the train is moving, and which must be considered as at rest, since no observations were taken to measure the amount of its effect. The amount of frontage may be called equal to the greatest cross section of the train increased by 10 square feet for each car including engine and tender.

Let bv^2 = this resistance in pounds at the velocity v of the train; then

$$f.\,\mathrm{T} \pm g\,(\mathrm{T} + \mathrm{W}) + bv^2 =$$

resistance from friction of load, gravity of the train, and the air.

6. One other obstacle to the progress of the train remains to be considered—the friction of the engine.

Let F = the friction of unloaded engine, being in this case 348 lb. or 12 lb. per ton.

Let r = additional friction due the load, to be measured as a fraction of the resistances summed up in (5), being for coupled engines about 22. Then

$$\mathrm{F} + r\,[f.\,\mathrm{T} \pm g\,(\mathrm{T} + \mathrm{W}) + bv^2]$$

will be the friction of the engine, when moving with the resistances here indicated. And we have for the *sum of resistances* encountered by this engine, when referred to the track,

$$\mathrm{S} = 1699 + 116\,p + \mathrm{F} + (1 + r)\,[f.\,\mathrm{T} \pm g\,(\mathrm{T} + \mathrm{W}) + bv^2].$$

Let us reduce this equation for a velocity of 23 miles per hour, being the average speed of train No. 1 during 2·26 miles, the most unexceptionable on a level tangent, as to attending circumstances; pressure in the boiler as indicated by the steam gauge being 124 lb.

P = atmospheric pressure on pistons, in lbs	1699
p = 8; then $116\,p$ =	928
F =	348

$g = 0$

f = 5·7 lb. per ton gross.

T = 438 − 29 = 409 tons gross.

W = 29 tons gross.

Frontage of train = 110 + 28 × 10 = 390 square feet.

$bv^2 = 390 \times 1{\cdot}6$ lb. = 624 lb.

$1 + r = 1{\cdot}22$.

Hence then

$$(1 + r)\,[f.\,\mathrm{T} \pm g\,(\mathrm{T} + \mathrm{W}) + bv^2] = \ldots\ldots 3605$$

and S = ... 6580

This amount of resistance is equivalent to the gravity on a grade of 35·3 feet per mile, which is the *grade of double resistance* for this train at a speed of 23 miles per hour, with a steam pressure of 124 lb.

Train No. 2 with the same pressure in the boiler was removed 3·5 miles at the rate of about 20 miles per hour on a level tangent. In the same formula

$p = 6$; then $116\,p = 696$ lb.

S = 512 − 29 = 483 tons gross.

Frontage and effective surface of train is 110 + 33 × 10 = 440 square feet.

$bv^2 = 440 \times 1{\cdot}2 = 528$ lb. Then S = 6746 lb.

Gravity will equal this amount of resistance on a grade of 31 feet per mile.

Hence, then, other things being the same, we find that for train No. 1, moving with a velocity of 23 miles per hour, the grade demanding an outlay of power double the amount required on a level, is 35·3 feet per mile. In other words, for this train, one mile of 35·3 feet grade ascending, would equal two miles of level line. While for No. 2, moving at 20 miles an hour, the power must be doubled on a grade of 31 feet per mile.

Concerning the effect of velocity, we observe that with a load nearly one-fifth greater, the resistances are increased but 5 per cent. if the speed be reduced 43 per cent.

Thus, when a sufficient number of experiments have been made with care, it will be found valuable to prepare a table of results, and from this table the locating engineer may, with sufficient accuracy, determine the "equation of grades," for the class of road he is about estimating.

Though these reflections are independent of the experiments we are to consider, it is hoped they may not be thought useless. Nor will they, when it is remembered that important errors are frequently made by those who assume a constant quantity in "equating distances" on lines under investigation for estimates. So great is the error that not even an average can be made for trains presenting considerable differences in their composition.

In examining the data collected in a series of experiments on the effect of curvature, we shall notice greater departures from a formula based on any one, than in cases of grades on tangents. This will be the case in the present instances; for while on some parts of the road the track is properly prepared by bending to the curves, it is in other cases laid more carelessly, and is in some of the sharpest curves nearly straight. So that in passing from rail to rail the resistance from concussion is by no means inconsiderable.

In the following table will be found the results condensed, of all the reliable data gathered on 200 miles east from Dunkirk. The cases are gleaned from the mass and averaged; a practice that as before remarked, is dangerous, where entire accuracy is sought, yet one to which it is necessary to resort, unless the

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General Characteristic of Line.	Number of experiment	Number of Train.	Grade.—Ascent in feet per mile.	Alignement.	Total Amount of Curvature in Degrees.	Boiler Pressure indicated by steam gauge in pounds per square inch	Effected Vaporisation, in cubic feet of water per hour.	Velocity actually accomplished, in miles per hour.	Velocity demanded by Formula, on Tangent.	Difference for correction, in miles per hour	Difference due Curvature expressed as a fraction of the effect demanded.
Level Tangent.....	1	1	0	Tangent.....	° —	124	210	23·0	23·7	0·7 } av. 0·8	—
,, ,, ...	2	2	0	,, ...	—	124	190	19·9	20·9	1·0 }	—
,, ,, ...	3	3	0	,, ...	—	130	141	8·0	8·0	0·0	—
Ascending Tangent	4	2	40	,, ...	—	130	141	7·0	7·0	0·0	—
Level Curve	5	1	0	1° Curvature	53	125	210	22·5	23·7	0·8	·01
,, ,, ...	6	2	0	3° Curvature	158	110	165	16·0	18·3	0·8	·08
,, ,, ...	7	1	0	Compound 1° 2° & 3°	85	120	165	18·3	20·0	0·8	·045
,, ,, ...	8	1	0	,, 1¼° & 3°	82	120	165	17·9	20·0	0·8	·065
Ascending Curve...	9	1	24	1° Curvature	53	120	155	12·6	13·2	0·4	·014
,, ,, ...	10	1	40	4° ,, ...	211	130	136	5·4	7·4	0·0	·27
,, ,, ...	11	1	40	3° ,, ...	158	115	137	5·9	7·5	0·0	·21

experiments are conducted with especial reference to this use. And even then the results obtained on various roads must be averaged for the construction of reliable tables for practical purposes.

The results are arranged to proceed from the simplest case to the most complicated, and are numbered as separate experiments. The first four in the list are the average of many observations, and are used as corrections for the curves.

To ascertain the effect of curvature we shall first examine the resistances opposed to each train as if on a tangent, then the total resistance actually overcome by the train on the various curves. The difference between those results will be the amount of resistance due curvature.

De Pambour's formula for the velocity at which a certain load may be drawn by a locomotive is used, with a change in the symbols for the convenience of those whose duties call them to know more of railroads than the dead languages.

The formula will then stand—

$$V = \frac{1}{5280} \cdot \frac{1}{q} \cdot \frac{1}{1+c} \times \frac{E}{(1+r)[(f \pm g)T \pm g W + bv^2] + F + \frac{d^2 l}{D}(\frac{n}{q} + a + 144p)} =$$

velocity in miles per hour, when

E = Effective vaporisation of the engine, in cubic feet of water per hour.

q = Factor expressing volume of steam proportioned to the pressure = ·00000023 when the pressure is given in pounds per square foot.

n = Constant quantity relative to the volume of steam, its value being ·0001421.

l = Length of stroke of piston.

c = Clearance of the cylinder, equal in this instance to $\frac{1}{12}$ of the useful stroke of the piston, which gives $\frac{1}{1+c} = \frac{12}{13}$.

a = Atmospheric pressure, equal to 2117 lb. per square foot.

d = Diameter of cylinder.

D = Diameter of driving wheel.

The total heating surface of the boiler = 1105 square feet. The diameter of blast orifice should have been stated at 3 inches. The equation when reduced by the substitution of these values will read—

$$V = \frac{798\ E}{1{\cdot}22\,[(5{\cdot}7 \pm g)T \pm gW + b v^2] + 348 + 0{\cdot}8\,(2736 + 144p)}.$$

To illustrate the use of this formula, let us apply it to the circumstances of train No. 1. We shall have by making proper substitutions, the equation

$$V = \frac{798 \times 210}{1{\cdot}22[5{\cdot}7 \times 409 + 624] + 348 + 0{\cdot}8(2736 + 1152)} = \begin{cases} 23{\cdot}7 \text{ mile} \\ \text{per hour.} \end{cases}$$

It is thus we arrive at the amounts stated in the table under the head of "Velocity Demanded."

It is to be noticed that in the experiments on level tangents, the actual effect is somewhat below the estimated powers of the engine; also, that, as the velocity increases, the difference becomes greater.

This was perhaps to be expected. During a part of the time the adhesive power of the driver was affected by a leakage of the pumps, which wet the rail. The track is, moreover, exceedingly rough in places; though the quantity given above as the friction of the cars, being 5 lb. per net ton, is in accordance with information received from the general superintendent of the Erie-road.

In addition to these causes of difference, it may be remarked that there was at times some wind; but as these are culled instances, it is believed they are free from any considerable influence beyond a quiet atmosphere. In No. 1, at a velocity of 22 miles per hour, there is a difference between the actual and possible effect, of 3 per cent. of the work done.

In No. 2, at a velocity of 20 miles per hour, this difference amounts to 5 per cent.

In No. 3, the velocity being 8 miles per hour, the difference was too slight to be noted.

In No. 4, at a velocity of 7 miles per hour, the difference was equally unnoticable.

Suppose there be similar relations throughout, these amounts must for practical purposes be applied as corrections to the experiments on curves.

If therefore, the amounts in the column of differences be added to the velocity actually accomplished, and the sum be deducted from the velocity demanded, we shall have presented the effect of curvature, which in the table is noted as a fraction of the effect demanded, after correction.

It would be useless of course to found a law on these results. They are believed to be most carefully observed, and so far as they go are certainly correct. What are noted as single experiments, are really classes of observations. But we must have more considerable data from many roads before the results obtained can be made available for the purposes of the locating engineer—who, as before remarked, must be governed by the nature of the business to be done on the lines under consideration.

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LIST OF PETITIONS FOR PRIVATE BILLS; SESSION 1856.

Deposited at the Private Bill Office, on or before the 31st of December 1855.

Leicester and Welford Road.
Halifax and Huddersfield Road.
Prisoners' Discharge Society.
Norwich Union Life Insurance Society.
Barnsdale and Leeds Turnpike Road.
North Staffordshire Railway (Sandbach to Warrington).
Cheltenham Gas.
North of Europe Steam Navigation Company.
Cambridge University and Town.
Lancaster Gas.
Heywood Gas.
Eastern Union Railway.
Worcester and Hereford Railway.
Knaresborough and Pately Bridge Road.
Knaresborough and Green Hammerton Road.
Lowestoft and Beccles Railway.
Coventry (City) Gas.
Gloucester Gas.
London Dock.
Colonial Bank.
Stockton and Middlesbrough New Road and Bridge.
Filey Water.
Weymouth and Melcombe Regis Gas.
Cork and Youghal Railway.
Deeping Fen Drainage.
Thames and Medway Rivers Conservancy.
Uttoxeter and Blythe Marsh Road.
Aberdeen and Scottish Midland Junction Railway Companies Amalgamation.
Lambeth Water.
Glasgow Court Houses and Public Offices.
Glasgow Paving.
North Western Railway of Ireland.
Banbridge Junction Railway.
Southport Water.
Lincoln Water.
Cannock Mineral Railway Extensions.
Brough and Eamont Bridge Road.
Salisbury Market Branch Railway and Market House.
Lands Improvement Company of Scotland.
Dundee Harbour.
Sleaford and Tattershall Turnpike Trust.
West Ham Gas.
Colnbrook, Datchet and Slough Road.
Luton, Dunstable and Welwyn Junction Railway.
Luton District Road.
Yarmouth and Haddiscoe Railway.
Chatham District Water.
Knottingley Gas.
London and South Western Railway (Dorchester to Exeter).
British and American Great Railway Land Company.
Monmouth Roads.
Clay Cross Water.
Bath Gas.
Midland Great Western Railway of Ireland.
North Shields and Tynemouth Dock.
Renfrewshire Roads.
Scottish Central Railway (Branch Railways to Denny).
Alford Valley Railway.
Formartine and Buchan Railway.
Oxford, Worcester and Wolverhampton Railway (Extension of Time, &c.)
Oxford, Worcester and Wolverhampton Railway (Additional Capital, &c.)
East Somerset Railway.
Carmarthen and Cardigan Railway.
East of Fife Railway.
Llanidloes and Newtown Railway.
Conway and Llandudno Railway.
Broadstairs Harbour, Pier and Landing Place.
Darenth Valley Railway.
Kinross-shire Railway.
Westminster Terminus Railway.
Isle of Wight Steam Bridge and Approaches.
North Staffordshire Railway (Liverpool Extension).
Dunblane, Doune and Callander Railway.
Edinburgh Municipality.
Edinburgh Water.
Rhosydd Railway.
North Western Railway.
Dorset Central Railway.
Severn Valley Railway.
Thames Haven Dock and Railway.
West London and Crystal Palace Railway.
Sittingbourne and Sheerness Railway.
Middlesbrough Extension and Improvement.
Ely Tidal Harbour and Railway.
Birkenhead Docks.
London and North Western Railway.
Shrewsbury and Welchpool Railway.
Eastern Counties Railway.
Grand Junction Water.
Worksop Gas.
Ulster Railway.
Bawtry and Tinsley Road.
Poole and Bourne Valley Railway.
Bardney, &c., Drainage.
Glastonbury and Bruton Railway.
East Kent Railway.
Swansea Vale Railway.
London and South Western Railway (Yeovil to Exeter).
Cork Bridges, Waterworks and Improvement.
Forest of Dean Central Railway.
Cleobury North and Ditton Priors District and Cleobury Mortimer District Roads.
Aberdeen and Scottish Midland Junction and Dundee and Arbroath Railway Companies.
Wandsworth and Putney Gas.
Londonderry and Enniskillen Railway.
Shrewsbury Water.
Shrewsbury and Hereford Railway.
Denny Junction Railway.
Wem and Bronygarth Roads.
Haslingden and Rawtenstall Water.
Bagenalstown and Wexford Railway.
North Staffordshire Railway, St. Helen's Canal and Railway, and Warrington and Stockport Railway Companies.
Crowland and Eye Road.
Dewsbury, Batley and Heckmondwike Water.
Driffield Navigation.
Hampstead Junction Railway.
Bournemouth Improvement and Pier.
London, Tilbury and Southend Railway (Increase of Capital, &c.)
London, Tilbury and Southend Railway (Extension and Branches).
Vale of Clwyd Railway.
Caterham Railway.
Stockton and Darlington and Newcastle and Carlisle Union Railway.
Perth Burgh and Harbour.
Perth, Almond Valley, and Merthven Railway.
Wycombe Railway.
Provincial Railways (London Joint Station).
Chester and Northop Road.
Kettering and Newport Pagnell Road.
Canada Company.
Lymington Railway.
Blackburn, &c., Roads.
Castle Douglas and Dumfries Railway.
Norfolk Railway.
Stockton and Darlington Railway.
London Printing and Publishing Company.
Doddington Rectory Division.
Milford Junction Railway.
Maybole and Girvan Railway.
Lewes, Eastbourne and Hailsham Road.
Tormoham Water.
Fleetwood, Preston and West Riding Junction Railway.
Metropolitan Railway.
Gainsborough Gas.
Crystal Palace Company.
Waveney Valley Railway.
Dover Water.
Scarborough Water.
Rotherham and Barnby Moor Road.
Rotherham and Swinton Road.
Stirling and Dunfermline Railway.
London Diocesan Church Building Society.
Dundalk and other Roads Turnpikes Abolition.
Honiton and Sidmouth Road.
Boston Gas.
St. Ives and West Cornwall Junction Railway.
Chorley Water.
Belfast Improvement.
Leeds Improvement Acts Amendment.
Midland Railway.
Barnsley Canal and Collieries Railways.
Wakefield Gas.
Moore and Warrington Railway.
Ceylon Railway Company.

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Leeds Water.
Stockport and Warrington Road.
Penrith and Cockermouth Roads.
Kirkwall Harbour.
Gravesend Improvement.
Imperial Hotel Company.
West of Fife Mineral Railway.
Inverness and Aberdeen Junction Railway.
Morayshire Railway.
Antrim and Coleraine Roads.
Killarney Junction Railway and Tralee and Killarney Railway.
London, Barking and Victoria Docks Junction Railway.
Donington Turnpike Trust.
Mid-Kent Direct Railway (Bromley to St. Mary's Cray).
Epsom and Leatherhead Railway.
Godley Lane Road.
Mid-Kent Railway (Bromley Extension).
Wimbledon and Croydon Railway.
North British Railway.
Colne Valley and Halstead Railway.
Aberdeen, Peterhead and Fraserburgh Railway.
Deeside and Alford Valley Railway Extension.
Stotfield and Lossiemouth Harbour Improvement.
Tottenham, Hornsey and Willesden Railway.
Thames Embankment and Railway.
Westminster Terminus Railway (West London Extension).
City of London Steam Packet Company.

Total number of Bills, 189.

INSTITUTION OF CIVIL ENGINEERS.

Dec. 18, 1855.—JAMES SIMPSON, Esq., President, in the Chair.

Annual General Meeting.

THE Report of the Council for the past Session was read, and the meeting proceeded to the election of the President, Vice-Presidents, and other Members and Associates of the Council for the ensuing year, after which the medals and premiums awarded for Papers were presented.

The depressing influence of political events upon works of civil enterprise was noticed; as were the excellent services of the military members, in their own peculiar sphere,—of the civil engineers in the Army-Works Corps,—in the organisation and construction of the hospital of Rankoi,—and in the performance of numerous other duties, whereby it was admitted, that a recurrence of the disasters of the last winter would in all probability be effectually provided against.

The Great International Exhibition of Products of Industry, held at Paris, was commented upon at some length; and was admitted to have been in some respects more interesting than that of London in 1851. There were better displays from the colonies; the machinery and wrought metals of the continent generally, and the agricultural implements and machinery of France in particular, exhibited great progress, and the foreign machines for textile fabrics showed more attention to accuracy of fitting, and considerable advance in mechanical skill. These features were more apparent, in consequence of the inadequate manner in which many important branches of British industry were represented; for instance, there were only two English locomotives among the twenty railway engines exhibited,—fourteen of which, however, bordered on the system introduced by Mr. Crampton. The models of the great works of civil engineering were, with few exceptions, exhibited only by the Ministry of Public Works of France, and by members of the Institution of Civil Engineers, and a well-merited tribute was paid to the excellent and liberal spirit which animated the fourteenth class, composed almost entirely of French engineers, by whom the only two grand prizes of honour were recommended to be awarded to Mr. Stephenson and Mr. Rendel, whilst the decoration of the Legion of Honour had been requested for Mr. Stephenson and Mr. Brunel, and a large number of prizes of honour, and of medals of the first and second classes, and honourable mention, had been awarded to other members and associates of the Institution.

Feeling the importance of the occasion, the Council had not hesitated to deprive the Institution, even for an inconveniently long period, of the services of Mr. Manby, the secretary, in order to his proceeding to Paris to fill the post of Vice-President of the XIVth Class (civil constructions), as soon as it was found that other members who had been appointed to the jury could not attend, and the manner in which the duties had been performed was noticed approvingly.

A short sketch was given of the principal works commenced, completed, or having made considerable progress during the past year, in Great Britain, on the Continent, in India, in the United States of America, and in the Colonies.

A historical notice of the various attempts to obtain the adoption of a plan for the sewerage of the metropolis, showed that since the year 1847, there had been created five commissions, all armed with powers to decide upon and to raise money for the execution of some comprehensive scheme; but that constant impediments had been opposed to this essential work, and even up to the last moment the valuable time of the Commissioners had been frittered away in useless and personal discussions upon crude theories, instead of devoting the energies and good sense of the Commissioners to devising means for executing plans which had received the approbation of the first engineering talent of the day. It was hoped, that the good sense and business habits of the newly-appointed representative commission would put an end to this state of things, and that this work, so important to the sanitary state of the metropolis, would forthwith be proceeded with.

The principal Papers read during the session were noticed and succinctly analysed, dwelling more particularly upon those for which Telford medals had been awarded to Messrs. J. Barton, E. E. Allen, R. A. Robinson, and J. Phillips, and Council premiums of Books to Messrs. J. Leslie, P. W. Barlow, J. Brunlees, F. Braithwaite, G. J. Munday, and L. E. Fletcher.

The presents of books, maps, &c. made to the Society, were mentioned, and thanks were offered to the donors.

The deceases of members were few, as compared with those announced at the last annual general meeting—they were Rear-Admiral Sir William Parry,—Honorary Member; Lieut.-Colonel John Henderson, R.E., Messrs. John Brogden, jun., Alexander Comrie, Wyndham Harding, and Andrew Liddell,—Associates; and Charles Denroch, Graduate.

Memoirs of these deceased members of all classes, were ordered to be printed in the appendix to the Annual Report.

The resignations of ten members, associates, and graduates, were also announced.

The statement of the receipts and expenditure of the past year showed, that the funds had, at last, reached the point to which it had been the object of the Council to bring them. That there was an available balance sufficient for the annual publication of a volume containing the minutes of proceedings of the current session, and with any other funds that might be furnished, it was proposed to bring up the arrears of publication; the first part of Volume XIV. for the session 1854-55 had been issued, and with it a statement of the subscription to the Publication Fund, in the hope that by thus directing attention to the subject those members who had not hitherto contributed would be induced to do so. It was announced, that the second and concluding part of Volume XIV. was partially in type, and would be issued by the month of March; that in accordance with the instructions of the Council the papers read during the present session were already printed, and that the complete volume would be in the hands of the members as soon as was practicable after the end of the session, and the arrears were ordered to be printed with all speed, giving the discussions in those volumes in a more succinct form.

It was also stated, that in order to facilitate this arrangement, the President had taken upon himself the entire expenses of the annual conversazione.

The thanks of the Institution were unanimously voted to the President, for his liberality, and his attention to the duties of his post, to the Vice-Presidents and other members and associates of Council, for their support of the President and their constant attendance; as also to the auditors, the scrutineers of the ballot, and to the secretary, for their several services.

The following gentlemen were elected to fill the several offices in the Council for the ensuing year:—Robert Stephenson, M.P., President; G. P. Bidder, I. K. Brunel, J. Hawkshaw, and J. Locke, M.P., Vice-Presidents; W. G. Armstrong, J. E. Errington, J. Fowler, C. H. Gregory, T. Hawksley, J. R. McClean, J. Penn, J. S. Russell, J. Whitworth, and N. Wood, Members; and W. Piper and G. F. White, Associates.

It was not thought necessary to dwell at any great length upon the proceedings of the past session, but in retiring from the trust confided to them, the Council urged upon the members of all classes the importance of bearing in mind, that the Institution could only become prosperous and useful by their united efforts in upholding it, by furnishing good communications, by constant attendance at the meetings, and by taking part in the discussions. Reminding them that it was the province of civil engineers to add to the solid benefits conferred upon society by the discoveries of science and the labours of practical industry, and that, as it was the peculiar mission of the profession to take an active part in the great civil works of the period, so it was expected that they should freely communicate their knowledge, and place on record accounts of the labours of those whose names might be hoped to be handed down to posterity, as having deserved well of their country.

Jan. 8, 1856.—ROBERT STEPHENSON, ESQ., M.P., in the Chair.

The President, on taking the Chair for the first time since his election, handed in an address, which was read by the Secretary.

After a complimentary allusion to the addresses of his predecessors, the President observed, that he would apply himself to the great question of British Railways, which were described as spreading like a network over Great Britain and Ireland to the extent of 8054 miles completed; thus, in length, they exceeded the ten chief rivers of Europe united, and more than enough of single rails were laid to make a belt of iron around the globe.

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The cost of these lines had been 286,000,000*l.*, equal to one-third of the amount of the National Debt. Already, in two short years, there had been spent more than one-fourth of 286,000,000 in the war in which England was engaged; yet how small were the material advantages obtained by the war, in comparison with the results secured by railways.

The extent of the railway works was remarkable; they had penetrated the earth with tunnels to the extent of more than 50 miles; there were 11 miles of viaduct in the vicinity of the metropolis alone; the earth-works measured 550,000,000 of cubic yards; St. Paul's, in comparison with the mountain this earth would rear, would be but as a pigmy beside a giant, for it would form a pyramid a mile-and-a-half in height, with a base larger than St. James's Park.

Eighty millions of train miles were run annually on the railways, 5000 engines, and 150,000 vehicles composed the working stock. The engines, in a straight line, would extend from London to Chatham; the vehicles from London to Aberdeen; and the companies employed 90,400 officers and servants; whilst the engines consumed annually 2,000,000 tons of coals, so that in every minute of time 4 tons of coals flashed into steam 20 tons of water, an amount sufficient for the supply of the domestic and other wants of the town of Liverpool. The coal consumed was almost equal to the whole amount exported to foreign countries, and to one-half of the annual consumption of London.

In 1854, 111,000,000 of passengers were conveyed on railways; each passenger travelling an average of 12 miles. The old coaches carried an average of 10 passengers, and for the conveyance of 300,000 passengers a-day 12 miles each, there would have been required at least 10,000 coaches and 120,000 horses.

The receipts of the railways in 1854 amounted to 20,215,000*l.*, and there was no instance on record, in which the receipts of a railway had not been of continuous growth, even where portions of its traffic had been abstracted by competition or new lines.

The wear and tear was great; 20,000 tons of iron required to be replaced annually; and 26,000,000 of sleepers annually perished; 300,000 trees were annually felled to make good the loss of sleepers; and 300,000 trees could be grown on little less than 5000 acres of forest-land. The President considered at some length how these annual depreciations should be met. The principle of a renewal fund was questionable. After a certain period in the history of every railway, deterioration reached an annual average, and as that annual depreciation became a charge, as fixed and certain as the cost of fuel, or the salaries of officers, it should be admitted as an annual charge against receipts.

As regarded fares, the interests of the companies and of the public were identical; companies must regulate fares by consideration of the circumstances which produced the largest revenue, and the circumstances which produced the largest revenue were those which induced the greatest number of individuals to travel. Nothing was so profitable as passenger traffic, as it cost less in every way than goods, and an average train would carry 200 passengers. The cost of running a train was overstated at 15 pence per mile, and 100 passengers at five-eighths of a penny per mile produced 5*s.* 2½*d.* But this argument did not imply that, in all cases, fares should be fixed at a minimum. Minimum fares were most profitable on short routes; but the public were too much occupied to be tempted by minimum fares to undertake long journeys. High rates of speed and increased comforts were then required, and these might be charged for. Every case, therefore, should be treated in consideration of its local circumstances.

The Postal Facilities afforded by railways were very great. But for their existence, Mr. Rowland Hill's plan never could have been effectually carried out. Railways afforded the means of carrying bulk, which would have been fatal to the old mail coaches. Every Friday night, at present, when the weekly papers were transmitted, 8 or 10 vans were now required for Post-office bags on the North-Western Railway, and this use of 8 or 10 railway vans implied, at the least, the employment of 14 or 15 mail coaches; and the expenses of 14 or 15 mail coaches to Birmingham could never have been sustained by a penny postage. For this great blessing, therefore, the nation had to thank the railways. They were the great engines for the diffusion of knowledge. Government never could have carried *The Times*, of its present size, on the same terms, by the old mail coach. The Parliamentary blue books never would have been printed; for except by canal or by wagon, they could not have been distributed, and if they could not have been circulated, they would have been useless. Nevertheless, the Post-office did not appear to treat railways with all the consideration they were entitled to expect. Great services were required, and in return it had been contended, that no profit should be allowed to the railway companies, except as carriers and workers of the line. Railway companies were, therefore, indifferent to postal traffic; which was shown to be a serious disadvantage to the public. At present, the Post-office competed with railways, as carriers of book parcels, a principle which might be extended still further, but not without injustice and hardship to the railways.

Parliamentary legislation for railways was full of incongruities and absurdities, which were graphically described and illustrated. The Acts of Parliament which railways had been forced to obtain, had cost the public fourteen millions sterling. But this was shown to be the exclusive fault of Parliament itself, and of the system it enforced. The legislation of Parliament had made railways pay 70,000,000 of money to landowners for land and property; yet almost every estate traversed by a railway had been greatly improved in value. Parliament had taxed the companies in favour of the landowners, for what was called "severance." Claims for compensation for "severance" were based on theories which were wholly ideal and imaginary. No one had ever been able to show a practical loss by "severance," and the claim was often made as "customary," where it was even admitted that no ground for it existed. The remedy which suggested itself for this state of things was one which Parliament was not likely to grant. A competent tribunal was wanted; and Parliament was incompetent. Neither its practical experience, its time, nor its system, were adapted for railway legislation. If a mixed commission could be organised, to consist of practical men of acknowledged legal, commercial, and mechanical ability, there might be some chance of railway business being efficiently conducted. But, it was admitted, that there was little hope of any such concession.

Railway management was next considered, and shown to be completely anomalous. Parliament had legislated for railways as toll-taking companies; but every direction was obliged to embark in enterprises foreign to the parliamentary objects of the railway itself. This produced serious dilemmas. As long as dividends were kept up, the directors were popular, however illegal their acts; but the moment dividends fell, the directors, however energetic, wise, or prudent, were visited by the shareholders and the public with all the penalties of having exceeded the letter of the law. Men whose reputations were at stake were, consequently, unwilling to incur the risk of becoming railway directors; and the most enlightened managers and shareholders were revolving in their own minds how the dilemma could be escaped. It was suggested that advantage might be taken of the Limited Liability Act, or of some analagous measure, to enable a limited number of men of business to take lines of railway from shareholders on leases, subject to certain conditions and terms. A few of the lessees would then constitute themselves managers; and, being free from apprehensions on account of shareholders, of external interference, or of personal liabilities, they would be able fully to work the line and enter into those enterprises necessary for its development and essential to its prosperity. A large profit would accrue to those who took the line, and managed it with vigour and economy; whilst shareholders would derive great advantages from the certainty of receiving fixed divdends, and from the enhancement of the value of their property; and practical security would be afforded to the public, whilst their best interests would be consulted.

The Electric Telegraph—that offspring and indispensable companion of railways—was next considered. 7200 miles of telegraph, or 36,000 miles of wires, were laid down at least. 3000 people were continually employed, and more than a million of public messages were annually flashed along this "silent highway." To the working of railways, the telegraph had become essential. The needle was capable of indicating, at every station, whether the line was clear or blocked, or if accident had any where occurred. The telegraph could, therefore, do the work of additional rails, by imparting instantaneous information to the officers and enabling them to augment the traffic over those portions of the line to which their duty might apply. It also enabled large savings to be effected in rolling stock, by affording the means of supplying such stock, to any station at which it was needed, from some other station where it had accumulated and was not wanted. The mode in which this system was worked was described, and its simplicity was commended. As a perpetual current was passing through the wires, the guard, or engine driver had only to break the train-wire, in case of accident, and the officers at the nearest station were instantaneously apprized that something was wrong and that assistance was needed. Some statistics were given to show that the business of the Electric Telegraph Company had increased fifty-fold in seven years.

Railway accidents occurred to passengers in the first half of 1854 in the proportion of one accident to every 7,195,343 travellers. Ladies and gentlemen could scarcely "sit at home at ease" with the impunity with which it appeared they could travel by railway. How frequent, comparatively, were the accidents in the street; how fearful the misadventures to those "who go down to the sea in ships." Yet Parliament had seen fit to legislate expressly for accidents by railway, without legislating in the same way for accidents from other sorts of locomotion. This was unfair to railways, and ill-calculated to afford protection to the public where it was most needed. Lord Campbell's Act, also, measured men's lives by a class standard. The family of a high public functionary would get large compensation, whilst the family of the poor working man would get nothing. The practical tendency of this law was to retard the adoption of low fares. Railway managers were compelled to consider, not only what they might gain, but what they might lose; and the larger the number of passengers, the greater the risk of accident to some one of them. Tha companies were, practically, obliged to insure the life of every person who travelled on their line, without being able to apportion the premiums to the risks incurred.

The results of railways were astounding: 90,000 men were employed directly, and upwards of 40,000 collaterally;—130,000 men, with their

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wives and families represented a population of 500,000 souls; so that 1 in 50 of the entire population of the kingdom might be said to be dependent upon railways! The annual receipt of railways now reached 20 millions, or nearly half the amount of the ordinary revenue of the state. If railway intercourse were suspended, the same amount of traffic could not be carried on under a cost of 60 millions per annum; so that 40 millions a-year were saved by railways. To the public "time is money," and, in point of time, a further saving was effected; for on every journey averaging 12 miles in length, an hour was saved to 111 millions of passengers per annum, which was equal to 38,000 years in the life of a man, working 8 hours a-day; and allowing an average of 3s. per diem for his work, this additional saving was 2,000,000*l.* a-year. The moral results of railways were equally remarkable; railways were equalising the value of land throughout the kingdom, by bringing distant properties practically nearer to the centre of consumption, and by facilitating the transit of manures; thus enabling poor lands to compete with superior soils. The stimulus afforded to national industry was exemplified, by the progress of the boiler-plate manufacture; and the increased comforts afforded to the people were illustrated by the extraordinary progress of the fish trade, and the development of the inland coal traffic. It was observed, that before railways existed, internal communication was restricted by physical circumstances: the canal traffic was dependent on the supply of water at the summit levels, and upon the vicissitudes of seasons of either drought or frost. Railway communication was free from all these difficulties, and every obstacle that nature had opposed, science had, hitherto, effectually surmounted.

The address concluded with some words of practical application: The duty devolved on civil engineers of improving and perfecting this vast system. Every farthing saved, on the train mileage of the kingdom, was 80,000*l.* a-year gained to railway companies. There was therefore ample field for economical appliances, and therefore no economical arrangement, however trifling, was to be neglected. Nothing would afford the President greater satisfaction, than that from his observations some sound practical improvement should result to a system with which his name, in consequence of his father's works, had been so largely associated; for however extensive his own connexion with railways, all he had known, and all he had himself done, was due to the parent whose memory he cherished and revered.

Referring to the benefits derived from the Institution, the President observed, that it was the arena wherein had been exhibited that intelligence and familiar knowledge of abstract and practical science, characterising the papers and discussions; in consequence of the constant intercourse within its walls, professional rivalry and competition were now conducted with feelings of mutual forbearance and conciliation, and the effort of the members were all directed in the path of enterprise and towards the fair reward of successful skill. The business of the civil engineers, from a craft, had become a profession, and by union and professional uprightness a great field was opened to energy and knowledge.

As to the proposal for shortening the tenure of the office of president, his opinions were well known, and remained unchanged; his mission, however, now was to conform to any course that was deemed for the general good; and all he asked was the support and assistance of the members, whilst he devoted his best energies to the performance of the duties of the office to which he had been elected.

Jan. 15.—The Paper read was "*On the relative proportions of the top, bottom, and middle webs of Iron Girders and Tubes.*" By J. M. HEPPEL, M. Inst. C.E.

The object of the Paper was the investigation of the forces to be resisted by the middle webs of girders. The first part of the inquiry had reference to the case of a plate of metal, subjected to the action of various direct forces, some compressile and others tensile, simultaneously applied to it, in different directions, and it was shown, that these might always be resolved into two principal resultants, which were invariably at right angles to each other, and by which the applied forces, however numerous might be conceived to be replaced,—the condition of the plate being absolutely the same, whether considered as subject to the forces originally applied, or to their two principal resultants.

The next point was the consideration of the condition of a rectangular plate, held in equilibrium by lateral forces, applied in couples uniformly distributed along its sides, and it was shown, that in this case, also there were two principal resultants: one tensile and the other compressile; that these two were of equal intensity, at right angles to each other, and at angles of 45° with the applied forces; moreover, that their intensity was exactly equal to that of the applied lateral forces.

It was next shown, that the middle web of a girder exposed to a load, at a given point, was exactly in the condition of the plate last considered, and a rule for the computation of its thickness was arrived at.

Other cases of the distribution of loads, both fixed and moveable, were then considered, and rules for the corresponding thickness deduced.

The effect of the horizontal strains to which the middle web was subject was then considered, and an investigation was made of the magnitude and direction of the resultants, arising from their composition with the diagonal forces before considered.

Finally the increase to be made in the thickness of the middle web, beyond that already arrived at, in order to enable it to deal with these horizontal and diagonal strains, together, was investigated, and a rule was deduced for its definite determination.

The results arrived at were briefly these:—Four different cases of distribution of the load being considered, and in the first instance, the horizontal forces being left out of consideration, and the thicknesses determined with reference to the diagonal forces only. These four cases were:

1. That in which the load was fixed and central.
2. That in which a load concentrated on a point, moved along from one end of the beam to the other—as the case of a concentrated rolling load.
3. That in which the load was fixed and uniformly distributed.
4. That in which a load uniformly distributed was drawn on from one end, or that of a distributed rolling load.

It was then shown, that in order to enable the middle web to deal with the diagonal strains, its thickness should be determined by the following methods:—

In the first case (the fixed central load), by making it of uniform thickness, and such that its horizontal section was equal in area to the central vertical sections.

In the other three cases, the thickness of the middle web, at the extremities, was twice that determined as above. In all of them it diminished towards the centre, but in each case according to a different law.

In the second case (the concentrated rolling load), the thickness varied as the distance from the more remote extremity.

In the third case, (the distributed fixed load), the thickness varied as the distance from the centre.

In the fourth case (the distributed rolling load), the thickness varied as the square of the distance from the more remote extremity.

The cases of combinations of these kinds of loads was then considered, and it was shown, that by dividing the central vertical section into portions, proportional to the amount of each kind, and thence determining the thicknesses from the middle web for each kind, according to its own laws,—the sums of the thicknesses so determined would give those necessary for dealing with the compound load.

The effect of the horizontal forces was next considered, and two cases were taken; first, that in which the section of the beam diminished from the centre towards the extremities, in the ratio of the rectangle of the segments of the length, in which case the horizontal forces were constant, or nearly so throughout.

In this case it was shown, that the thicknesses, as before determined, with reference to the diagonal forces alone, should be trebled, in order to fit them to resist the resultants arising from their composition with the horizontal forces; and, as in all beams, where any variation whatever was made in the vertical section, it did, or should approximate to the above law. It was considered, that this rule should be taken as applicable to beams of variable section.

For beams of uniform section, it was shown, that the thickness of the middle web should be such, that the horizontal section should be three times the vertical area.

The stiffening of the sides was then considered. It was argued, that, as the efficiency of stiffening must in some way depend on the amount of support applied to it, it might reasonably be supposed to be proportionate to a line which would form a web to the rectified periphery—a rectangle equal to the area to be supported—which line (borrowing a phrase from hydraulics), might be called "its mean radius." Reasons were then adduced, for believing that stiffening pieces might with safety be so distributed as to leave the mean radius of the included spaces equal to seventy times the thickness of the plate, although, in most early structures, it would be found to be much less than what would result from such a calculation.

Jan. 22.—The Paper read was "*On the Past and Present Condition of the River Thames.*" By H. ROBINSON, Assoc. Inst. C.E.

In the preliminary sketch it was shown, that the Thames had always excited considerable interest in the country, and that some change, or projected improvement in its condition, was rarely, if ever, excluded from the topics of the day. The principal statistical facts connected with the river were enumerated.

A description was then given of the various abuses which existed, during the last century, in the management of the upper navigation, and the efforts made to improve the disgraceful condition of the river. The various rival schemes by which this object was proposed to be effected were referred to, and it was shown how the plan for constructing a canal from Boulter's Lock to Isleworth, by which the worst and most circuitous part of the river would have been avoided, was continually defeated, though supported by the high authority of the engineers, Brindley, Mylne, Whitworth, and Rennie. This canal scheme had been called into existence by an old law, prohibiting the making of any locks below Maidenhead. The subsequent abrogation of this law, and the construction of six locks by Mr. Leach, at once improved the worst part of the river, and silenced the promoters of the canal scheme.

Leaving the upper navigation of the river, the Paper then referred to its condition in that part within the bounds of the Metropolis.

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The numerous shoals now exposed at low tide, the mud banks covered with putrefying matter and animalculæ, the disgusting state of the water itself, the numerous crazy wood-propped wharves, and the ricketty barges still serving for steam-boat piers, were referred to, as justifying the opinion that, were it not for the noble bridges spanning it, the Thames, within the limits of the metropolis, would be a disgrace at home, and a reproach abroad, and it was remarked that in no town in the world was there a noble river so neglected and deformed.

The various schemes for embanking the shores were then alluded to, and the partial good already effected, was noted. Among the larger designs were those of Sir Christopher Wren, Mr. Martin, Messrs. Walker and Burges, and others. The removal of the obstruction of old London bridge had seriously altered the condition of the river at or near low tide, not only by exposing shoals, which impeded the navigation, and, by leaving a very large surface of mud, giving off exhalations dangerous to health, but also by so quickening the current as to enable it to scour away the bottom, near the foundations of structures built in the channel, and thus seriously endangering several of the bridges and wharves. The chief cause of the numerous obstructions which had accumulated in the bed of the Thames, was described to be the very variable widths of the water-way, some of which were enumerated, showing that, among other anomalies, in one place the channel was only half the breadth that it was at another only a mile and a-half higher up. The principal feature of some of the embankment schemes was to secure, in place of these destructive variations, a gradually widening channel. The crowded state of the port of London was next noticed, and a summary given of the docks which were constructed in the beginning of the present century, and which were expected in some degree to relieve the river.

The first part of the Paper having been occupied in considering the Thames as a highway for commerce, the latter portion was devoted to describing the other functions which it, in common with all rivers, was intended to fulfil; the condition into which it had fallen, and the means proposed for restoring it to something like its normal condition.

The various causes which had induced the present polluted condition of the Thames, were described to be, first, the demand made upon it to serve as a town sewer as well as a land drain. This would however have been of little moment, if London had been beyond the influence of the tide, so that the stream could have run always in the same downward direction; but exposed as the river was to the ebb and flow of the tide, the impurities and sewage which had been discharged into the ebbing tide, were again brought back by the flood. Nor was this all; in consequence of the low level of a considerable part of the London sewers, the sewage was necessarily stopped back for many hours, and egress could not be afforded until the water had fallen considerably; the consequence of this was, that it was only during a portion of the ebbing tide, that the sewage was enabled to travel down the river, but it was returning upwards during the whole period of the flood tide, so that the impurities not only returned to the place whence they started, but were even carried higher up; and it was asserted that some of the putrefying matter, exhaling pestilential odours on the mud-banks in Westminster, was actually discharged from sewers at Bermondsey or Southwark. A short history was then given of the steps taken by the late Commissioners of Sewers, to remedy this putrid condition of the river. Mr. Frank Forster had originally arranged a system of intercepting sewers, by which the sewage of London was intended to be conveyed below Greenwich, and there discharged into the river, at an expense of one million and a quarter sterling. Nothing was, however, done for want of funds; subsequently Mr. Bazalgette, under the orders of the Commissioners, extended and completed the plans, and at an expense of three millions, laid out a complete system of intercepting sewers. The increased amount of the estimates rendered still more difficult the execution of the works, and nothing was done till the commencement of the past year, when public feeling loudly demanding some amelioration in the condition of the Thames, it was resolved to make at least a commencement; but all progress was stopped, the board disunited, and some of its most efficient members lost to it, by a controversy which arose regarding the size of the sewers, and by the official government support which was given to the pipe sewer party, in opposition to the decided opinions of the consulting engineers, the majority of the board, and their responsible professional advisers; this controversy still continued, and involving, as it was made to do, the question of asserted considerable economy, would probably still divide the new Metropolitan Board; whilst there was a large party, including those who looked with alarm at the whole interception scheme, those who considered the Thames as the best outlet, in spite of all consequences, and those who were totally indifferent to the question, except as regarded the tax which the expenditure would entail on them, who were not sorry to see any dissensions arise which would put off a final decision on the subject. These differences were, however, of the less importance, as there was little chance of such an enormous sum being raised at present, for the purpose, particularly as the mere stopping the entrance of any fresh sewage would not cleanse the Thames under many years, if at all, nor remove the acknowledged principal source of malaria—the mud banks exposed at low tide. There was, therefore, every reason to fear that the salutary agitation which had been excited on this important subject, would again die away, and leave the sewage undiverted and the Thames uncleansed, until a fresh visitation of malignant cholera again aroused the public feeling.

It was stated to be partly with a view to prevent a result so much to be deplored, that a plan had been proposed by the author of the Paper, by which, at a comparatively small expense, the Thames would be made to act as its own scavenger, the mud banks totally disappearing, and the water being purified, at the same time that the foundations of the bridges would be secured, and considerable advantages would be afforded to the navigation. The proposal was, to construct a chain of locks across the river, at or near London-bridge, where the traffic was now divided; to maintain a steady level of water above bridge at the most advantageous height, and to keep the water always moving in one direction, downwards; the sewage to be raised artificially at the mouths of the sewers, by simple mechanical means—not pumps—and thus discharged into a great body of moving water. The locks to be provided with sluices, always allowing the passage of the natural current of the river, and if found requisite, a greater egress to be periodically given at the time of ebb tide, say once in a week, on Saturday night, when the greater part of the water above bridge would be changed, and the river be filled up again with pure water by the time it was required for barge traffic on Monday morning: the locks would be closed for the first time at low tide, when a million tons of mud and filth, which had been so long accumulating and washing backwards and forwards, would have passed the dam, never to return. The river, replenished by pure water, would take up and dissolve much of the impurities, which would still be left; the constant repetition of this system must end by removing all the stagnant impurities, and by getting the river full of clear water. The consequences to the navigation were briefly touched on, and the Paper concluded by expressing regret that no work existed, professedly devoted to gathering up and recording all that was most interesting in the present condition and past history of a river, which was truly described as being an object of pride and interest not to any particular district, but to the whole country and to every Englishman.

ROYAL SCOTTISH SOCIETY OF ARTS.

"*On a peculiar Mechanical Imitation of Electro-Magnetic Rotation.*" By JAMES ELLIOT, V.P.

In this communication the author first describes the singular phenomenon of electro-magnetic revolution, first discovered by Professor Faraday, viz., that each pole of a magnet has a tendency to revolve round an electric current, that the two poles tend to revolve in opposite directions, and that the directions of rotation of each are changed by a change in the direction of the current. He then proceeds to show the difficulty of forming any hypothesis regarding the way in which such revolutions can arise by any known mode of operation common to other departments of physics. The first difficulty arises from the fact that the electric current is wholly confined to the conducting wire, while its magnetic effects are external to it. This difficulty the author endeavours to show by reference to other phenomena; and by direct experiment, is not insuperable. But, supposing it to be overcome, another more formidable meets us. How can a current in a rectilineal direction produce a revolution in a plane perpendicular to that direction without the agency of rigid mechanism? The only known case resembling it is that of a current of fluid directed upon oblique vanes, free to move only in a plane perpendicular to the direction of the current; but to render the cases strictly parallel, he shows that such a peculiar molecular structure would be necessary in the magnet, and such an incessant change in the position of its atoms during the revolution as to render the hypothesis of any similarity of cause too complicated to be admissible. The author then, after discussing the possibility of several hypothetical modes of operation, proceeded so show experimentally, that, if a magnet be made to rotate on its axis, resting on a fixed point coincident with its centre of gravity, and if while so rotating, its pole be brought near either pole of a fixed magnet, the rotating magnet revolves round the fixed magnet, the direction of revolution varying with the relative positions of the poles. When the adjacent poles are of the same name, the direction of the revolution is the same as that of the rotation; but when the adjacent poles are of different names, the direction of revolution is contrary to that of rotation. We have thus a motion precisely resembling electro-magnetic revolution, produced on well-known physical principle. How far there may be any similarity in their causes remains for consideration.

"*Suggestions for Increasing the Speed of Steam-Boats.*" By ROBERT AYTOUN, W.S.

Mr. Aytoun stated that the well-known proposition in hydraulics, *that the power required to impel a boat increases as the square of the velocity*, has exercised a pernicious influence over the minds of shipbuilders, in making them look upon it as hopeless to attempt any great increase of speed, which was to be attended by such enormous increase of power. This proposition, by showing the impossibility of greatly increasing speed with any of the known forms of boats, by giving them increased power, clearly indicated that the path of improvement, if any,

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must lie in new forms, calculated to take advantage of the new power of the marine steam-engine. It at once occurred to the author that by elongating the bow of the vessel, that water which our present steamboats dash aside from their path with great force and velocity, and the rapid removal of which absorbs the whole power of the engine, might be laid aside comparatively slowly and gently, like the sod from a Scotch plough, however great the speed of the vessel. A diagram was here shown, exhibiting three steamboats, whose midship sections were all equal, but the length of whose bows were respectively 1, 2, and 3. It was pointed out that, when No. 2 had twice the speed of No. 1, it dashed aside the water in its path with no greater velocity than did No. 1, and therefore did not require more steam-power, though proceeding at double speed. That when No. 3 had thrice the speed of No. 1, it dashed aside the water in its path with no greater velocity than did No. 1, and therefore did not require more steam-power, though proceeding at three times the speed. It thus appeared that the well-known proposition above referred to, which has so long paralysed the efforts of shipbuilders, must now give place to the more hopeful one, namely, *that the resistance to the motion of boats may be made the same for all velocities, by suiting the form of the boat to the velocity required of it.* A similar proposition, in regard to railways, was early made by Mr. Maclaren, with the happiest results, at a time when eight or ten miles an hour was the greatest speed they were thought capable of achieving. The author stated that it was to be hoped that our enterprising shipbuilders will not be slow in realising the same speed in steamboats which the railway engineers have done on the rail, and that by the elaboration of the self-same proposition, namely *that the resistance to motion may be made the same for all velocities.* A considerable advance in speed has been attained of late years by *fining the lines* of steamboats, by cutting them in two, and inserting an addition to their length amidships, or by increasing their original length, though this last is often marred by a proportionately increased breadth of beam. That these were all steps in the right direction, and tend to support the principle just stated; but that nothing short of an attempt to reach thirty or forty miles an hour will satisfy the occasion.—Mr. Sang, Mr. Elliott, and Mr. Swan discussed the subject of the paper at some length; and while they admitted, as mathematicians, the correctness of the principle advanced by Mr. Aytoun, considered that that gentleman had not given sufficient weight to other sources of resistance to the motion of boats, such as friction, which would become very formidable when boats of the great length which he advocated were urged to extreme speed.

"*Notice regarding Mr. Robert H. Bow's paper on New Designs for Iron Roofs of Great Clear Span.* By ROBERT MALLET, C.E.

Mr. Mallet referred, in a highly complimentary manner to Mr. Bow's paper, but begged permission to correct the statement that the designs were new, as he himself had made extensive use of such roofs; that they had been previously proposed by Mr. Adams, of London, and at a still earlier date were known in France.

"*On the Subject of Mr. Mallet's Letter, with Results of some Further Investigations.*" By R. H. BOW, C.E.

Mr. Bow stated that he was not aware of the existence of similar roofs to those proposed by himself, until after the reading of his paper to the Society; that, however, he never took much credit for the mere designs, but put the chief value upon the investigations, which proved the superiority of these over the form of roof most frequently employed for railway stations. He considered Mr. Mallet's letter as very valuable, as giving the history of the leading form of the designs, and thought the extensive adoption of this class of roofs reflected the greatest credit upon Mr. Mallet. Mr. Bow gave results of some further investigations, and stated that these had pointed out to himself the erroneousness of an impression he had entertained, viz., the designs were peculiarly suited for *great spans* only, or where many supported points were desirable for the rafters; whereas it was now proved that these roofs were pre-eminently suitable for *all* spans.

REVIEWS

The Illustrated Handbook of Architecture; being a concise and Popular Account of the Different Styles of Architecture prevailing in all ages and countries. By JAMES FERGUSSON, M.R.I.B.A. London: John Murray, Albemarle-street. 1855.

Numerous as are the text-books to art already before the public, the one just issued throws all previous efforts completely into the shade. Not more indispensable than are Murray's handbooks to the traveller who wishes to understand and enjoy the scenes through which he passes, will henceforth be Mr. Fergusson's to those who, within the limit it may be of their own circle, desire an acquaintance with the history and mystery of bygone ages in the ancient craft of architecture. In the two compact and elegant volumes before us, is condensed a mine of information on the subject, which unlimited resources alone, both of patience and materials, could have enabled the author to amass. We are not afraid that this popularizing of architecture can have any but a beneficial effect, for though occasionally we find individuals, with Stuart or glossary in hand, evolving for themselves castles, destined by neglect of the unalterable laws of gravity to exist only "in the air;" or, if allowing of tangible construction, such abominations as neither the designer nor beholder can ever look upon with complacency. In the majority of instances we have reason to know that these familiarly written books do great service in initiating the mind, if only so far as to render it a delightful medium of enjoyment, to trace through the labyrinths of centuries the means and motives which have given rise to successive structures, and to detect in each the characteristic imprint of its respective age. Persons, too, in whom a true feeling for art is thus implanted, will not become presumptuous dabblers on their own account, but wisely leave to those whose whole study it has been, and is, the legitimate exercise of an art which, beyond most, is calculated to ennoble, elevate, and benefit mankind.

On examining this "Hand-book" it will be at once apparent that the whole is compiled on a system, the styles of each country being successively followed out in minor as well as in general details, and, as far as possible, the whole series of illustrations drawn to a uniform scale. The labour entailed by the latter plan alone is incalculable, but the result in point of utility for reference is quite commensurate, and stamps a peculiar "comparative" value on the work. These illustrations, it should also be remarked, are profuse and exquisitely engraved; they number upwards of 800, while the fact that some are borrowed from other sources, so far from militating against the author, has avowedly enabled him to present a much more complete series than could have been otherwise contrived, without materially adding to the cost of production.

The work is divided into two parts; the first, consisting of nine chapters, treats of primæval and early structures; the second, in ten chapters, of Christian architecture. A distinct classification is allotted to certain styles, hitherto known only in general terms, thus showing that an amount of authorities must have been consulted, and investigation pursued to its very utmost limit. The author's personal researches in India have enabled him to produce a valuable essay on Buddhist, Jaina, and Hindoo architecture, and to furnish an interesting account of what is known of that of the neighbouring empire of China. Even the remains in central America are not overlooked, nor those in central Asia, designated as "Sassanian." The recent discoveries in Assyria, also, form the basis of a most interesting chapter. From some of these we shall by and bye make extracts which will show, at once, both the author's views and his style of writing. His most earnest desire, as he states in the preface, has been to place in the hands of the public a book which shall be deemed worthy of that noble art, to the study of whose principles he has devoted the best years of his life, and the best energies of his mind.

In a general introduction, Mr. Fergusson states pretty much at length his own opinions on architecture, as it is and as it should be; opinions which, coming as they do from one who has had full opportunities of judging, and who, moreover, is not trammelled by the routine of the usual professional education, will, at least, be unprejudiced, and so far have greater weight. After some general remarks, the distinctions of a builder, engineer, and architect, are thus defined:—"The art of the builder consists in merely heaping materials together, so as to attain the desired end in the speediest and readiest fashion. The art of the civil or military engineer consists in selecting the best and most appropriate materials he has in view, and using these in the most scientific manner, so as to ensure an economical but satisfactory result. Where the engineer leaves off, the art of the architect begins. His object is to arrange the materials of the engineer, not so much with regard to economical as to artistic effects, and, by light and shade, and outline, to produce a form that, in itself, shall be permanently beautiful. He then adds ornament, which, by its meaning, doubles the effect of the disposition he has just made, and, by its elegance, throws a charm over the whole composition." The elements of architectural treatment are next canvassed, as regards—mass, stability, materials, construction, forms, proportion, ornament, colour, uniformity, imitation of nature, ethnography, new style, and prospects. The pyramids and topes of the Buddhists are quoted as examples of massive effect, and the Hall of Karnac of more refined stability. In the

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same category is placed Norman architecture, whose massiveness is attributed more to clumsiness and want of constructive skill than design. While allowing this to some extent, it may be questioned whether a people who exhibited such exquisite skill in ornamental carving, and often delicate finish, were not capable of adopting, had they preferred it, a lighter mode of construction. Even by the author's own admission, "in our own country no building is more entirely satisfactory than the nave at Winchester, where the width of the pillars exceeds that of the aisles;" instancing, by way of contrast, the choir of Beauvais, which he truly calls "an overstrained exercise of mechanical cleverness."

Another very obvious mode of obtaining architectural effect is, by the largeness or expensiveness of the materials employed. The first of these means is at once apparent, provided that certain portions are sufficiently defined as to positive bulk, to enable the spectator to form a correct judgment of the real magnitude of the whole. The grandeur of the Arc d'Etoile, at Paris, is overwhelming on a near inspection, yet, at a short distance, how false is the impression. That gigantic mass, so beautifully finished and detailed, has then nothing to suggest its being other than an ordinary sized work, simply because every part is equally magnified, even to colossal sculpture and masonry. Its standing so detached, too, helps the illusion; and it is only when some pigmy individual at its base is taken into account, that a true conception can be formed of the actual fact. The same defect is inevitably noticeable in the interior of St. Peter's, at Rome. In the middle ages, the architects not only aspired to the erection of majestic edifices, but they learnt how they might greatly increase the apparent dimensions of a building by a scientific disposition of the parts, and a skilful arrangement of ornament, making it look very much larger than it really was. Yet, Mr. Fergusson, while admitting this, does not allow to their works the effect of *massive* grandeur. They "sought to replace it," he says, "by the display of constructive skill in the employment of the smaller materials they used, but it is extremely questionable whether in so doing they did not miss one of the most obvious and most important elements of architectural design." But, if a drawback this be, it is an error on the right side. The primary use of materials is to construct; beyond this, building merges into ornament. Still, for the sake of this latter, an architect ought always to allow himself such a margin of strength that he may disregard or play with his construction; while, in nine cases out of ten, the money spent in obtaining this solidity will be more effective, architecturally, than twice the amount expended on ornament, however elegant and appropriate that may be. As our author continues in illustration:—

"So convinced were the Egyptians and Greeks of this principle that they never used any other constructive expedient than a perpendicular wall or prop, supporting a horizontal beam, and half the satisfactory effect of their buildings arises from their adhering to this simple though expensive mode of construction. They were perfectly acquainted with the use of the arch and its properties, but they knew that its employment would introduce complexity and confusion into their designs, and, therefore, they wisely rejected it. Even to the present day the Hindus refuse to use the arch, though it has long been employed in their country by the Mahometans. As they quaintly express it, 'an arch never sleeps,' and it is true that by its thrust and pressure it is always tending to tear a building to pieces; in spite of all counterpoises, whenever the smallest damage is done, it hastens the ruin of a building, which, if more simply constructed, might last for ages.

The Romans were the first who introduced a more complicated style. They wanted larger and more complex buildings than had been before required, and they also employed brick to a great extent even in their temples and most monumental buildings. They obtained both space and variety by these means, with comparatively little trouble or expense; but we miss in all their works that repose and harmony which is the great charm that pervades the buildings of their predecessors.

The Gothic architects went even beyond the Romans in this respect. They prided themselves on their constructive skill; and paraded it on all occasions; and often to an extent very destructive of true architectural design. The lower story of a French cathedral is generally very satisfactory; the walls are thick and solid, and the buttresses, when not choked up with chapels, just sufficient for shadow and relief; but the architects of that country were seized with a mania for clerestories of gigantic height, and which should appear internally mere walls of painted glass divided by mullions. This could only be effected either by encumbering the floor of the church with piers of inconvenient thickness or by a system of buttressing outside. The latter was the expedient adopted; but notwithstanding the ingenuity with which it was carried out, and the elegance of many of the forms and ornaments used, it was singularly destructive of true architectural effect. It not only produces confusion of outline and a total want of repose, but it is eminently suggestive of weakness, and one cannot help feeling that if one of these props were removed, the whole would tumble down like a house of cards.

This was hardly ever the case in England: the less ambitious dimensions employed in this country enabled the architects to dispense in a great measure with these adjuncts, and when flying buttresses are used, they look more as if employed to suggest the idea of perfect security than as necessary to stability. Owing to this cause the French never were able to construct a satisfactory vault in consequence of the weakness of their supports; they were forced to stilt, twist, and dome their vaults to a most unpleasing extent, and to attend to constructive instead of artistic necessities. With the English architects this never was the case; they always were able to design their vaults in such forms as they thought would be most beautiful artistically, and, owing to the greater solidity of their supports, to carry them out as designed.*

It was left for the Germans to carry this system to its acme of absurdity. Half the merit of the old round arched Gothic cathedrals on the Rhine consists in their solidity and the repose they display in every part. Their walls and other essential constructious are always in themselves sufficient to support the roofs and vaults, and no constructive contrivance is seen anywhere; but when the Germans adopted the pointed style, their builders—they cannot be called architects—seemed to think that the whole art consisted in supporting the widest possible vaults on the thinest possible pillars, and in constructing the tallest windows with the most attenuated mullions. The consequence is, that, though their constructive skill still excites the wonder of the mason or engineer, the artist or the architect turns from the cold vaults and lean piers of their later cathedrals with a painful feeling of unsatisfied expectation, and wonders how such dimensions and such details should produce so utterly unsatisfactory a result."

In speaking of the effect of expensiveness of materials, the influence is attributed to one or more undefinable causes. We all admire an ornament of pure gold more than one that is only silver gilt, though few can detect the difference. Persons will travel hundreds of miles to see a great diamond or wonderful pearl, who would not go as many yards to see paste models of them, however closely imitated. Marble excites more admiration than stone, even though the colour of the latter be really as beautiful, and the material as durable; unless, perchance, an amount of labour have been expended in enriching the latter surface, or some peculiar dexterity have been shown in the manner of putting the work together. Some of the most eloquent trains of thought we can call to mind on this subject are those penned by Mr. Ruskin in his "Lamps of Sacrifice" and of "Beauty." In a somewhat different vein, Mr. Fergusson published a few years since his 'Inquiry into the True Principles of Beauty in Art,' some of the ideas in which he has transferred in speaking of "Forms" and "Proportion." Thus:—

"It is only by a combination of several notes that harmony is produced, and gentle or brilliant melodies by their fading into one another, or by strongly marked contrasts. So it is with forms: the square and angular are expressive of strength and power; curves of softness and elegance; and beauty is produced by effective combination of the right-lined with the curvilinear.† It is always thus in nature. Rocks and all the harder substances are rough and angular, and marked by strong contrasts and deep lines. Even among trees the oak is rugged, and its branches are at right angles to its stem, or to one another. The lines of the willow are rounded, and flowing. The forms of children and women are round and full, and free from violent contrasts; those of men are abrupt, hard, and angular in proportion to the vigour and strength of their frame.

In consequence of these properties, as a general rule, the square parts ought always to be placed below, where strength is wanted, and the rounded above. If, for instance, a tower is to be built, the lower story should not only be square, but should be marked by buttresses or other strong lines, and the masonry rusticated, so as to convey even a greater appearance of strength. Above this, if the square form is still retained, it may be with more elegance and less accentuation. The form may then change to an octagon, that to a polygon of sixteen sides, and then be surmounted by a circular form of any sort. These conditions are not absolute, but the reverse arrangement would be manifestly absurd. A tower with a circular base and a square upper story is what almost no art could render tolerable, while the other pleases by its innate fitness without any extraordinary effort of design.

On the other hand, round pillars are more pleasing as supports for a square architrave, not so much from any inherent fitness for the purpose as from the effect of contrast, and flat friezes preferable to curved ones of the late Roman styles from the same cause. The angular mouldings

* "It may be suggested that the glory of a French clerestory filled with stained glass made up for all these defects, and it may be true that it did so; but in that case the architecture was sacrificed to the sister art of painting, and is not the less bad in itself because it enabled that art to display its charms with so much brilliancy."

† "There are some admirable remarks on this subject in Mr. E. L. Garbett's 'Rudimentary Treatise on the Principles of Design in Architecture;' a work that contains more information, and more common-sense criticism on the subject, than perhaps any other in our language."

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introduced among the circular shafts of a Gothic coupled pillar add immensely to the brilliancy of effect. Where everything is square and rugged, as in a Druidical trilithon, the effect may be sublime, but it cannot be elegant; where everything is rounded, as in the Choragic Monument of Lysicrates, the perfection of elegance may be attained, but never sublimity. Perfection, as usual, lies between these extremes."

Some useful hints are given as to the proportioning of rooms, and different modes of partially correcting defects where they now occur. For instance, a room that is a perfect cube of 20 feet may be made to look as low as one only 15 feet high, by using a strongly marked decoration, by breaking the wall into different heights, by marking strongly the horizontal features, and obliterating as far as possible all vertical lines. The reverse process will produce an opposite effect. Then, externally, if the length of a building be too great, it is easily remedied by projections, or by breaking up the length into divisions. "If 100 feet in length by 50 feet high is a pleasing dimension for a certain design, and it is required that the building should be 500 feet long, it is only necessary to break it into five parts, and throw three back and two forward, or the contrary, and the proportion remains the same as before."

After treating of mouldings and other architectural members as so many varieties of ornament, the use of vegetable and conventional forms is thus discussed:—

"In certain styles of art, vegetable forms are employed even more frequently than those last described. Among these, perhaps the most beautiful and perfect ever invented was that known as the honeysuckle ornament, which the Greeks borrowed from the Assyrians, but made so peculiarly their own. It has all the conventional character of a purely lithic, with all the grace of a vegetable form; and as used with the Ionic order, is more nearly perfect than any other known.

The Romans made a step further towards a more direct imitation of nature in their employment of the acanthus leaf. As applied to a capital, or where the constructive form of the bell beneath it is still distinctly seen, it is unobjectionable; but when the leaf supports the volute at the angles of the abacus, it is on the very verge of good taste.

With their disregard of precedent, and untrammelled wildness of imagination, the Gothic architects tried every form of vegetable ornament, from the purest conventionalism, where the vegetable form can hardly be recognised, to the most literal imitation of nature.

By employing the former an architect can never sin against good taste, though he may miss many beauties; with the latter class of ornament he is always in danger of offence, and few have ever employed it without falling into mistakes. In the first place, because it is impossible to imitate perfectly foliage and flowers in stone; and secondly, because if the pliant forms of plants are made to support, or do the work of, hard stone, the incongruity is immediately apparent, and the more perfect the imitation the greater the mistake."

"In too many instances, even in the best Gothic architecture, the construction is so overlaid by imitative vegetable forms as to be concealed, and the work is apparently done by leaves or twigs, but in the earliest and purest style this is almost never the case. As a general rule it may be asserted that the best lithic ornaments are those which approach nearest to the grace and pliancy of plants, and that the best vegetable forms are those which most resemble the regularity and symmetry of those which are purely conventional."

Colour, it is remarked, is one of the most invaluable elements placed at the command of the architect, to enable him to give grace or finish to his designs. To an interior it is absolutely indispensable, and no apartment should be considered perfected till adorned by the refined touches of the painter.

"For 'tis not timber, wood, and stone,
An architect requires alone,
To finish a fine building.
The palace were but half complete,
If he could possibly forget
The carving and the gilding!"

The question of a "new style" is lightly ventured on, but it appears that the writer, taking an ethnological view of the subject, and sketching its history by the parallel of that of shipbuilding, is disposed to an affirmative opinio.; bearing in mind, too, our constantly transitional state, and the achievements of this age of progress. So far as we can argue from reason or experience, where forward progress is the law, it is certain that the next age will surpass the present; but the living cannot conceive anything more perfect, or they would apply it. As soon as the public are aware of the importance of this rule, and of its applicability to architecture, a new style must be the inevitable result; and if our civilisation is what we believe it to be, that style will not only be perfectly suited to all our wants and desires, but also more beautiful and more perfect than any that has ever existed before.

"In the confusion of ideas and of styles which now prevails, it is satisfactory to be able to contemplate, in the Crystal Palace at Sydenham, at least one great building carried out wholly in the principles of Gothic or of any true style of art. No material is used in it which is not the best for its purpose, no constructive expedient employed which was not absolutely essential, and it depends wholly for its effect on the arrangement of its parts and the display of its construction. So essentially is its principle the same which, as we have seen, animated Gothic architecture, that we hardly know even now how much of the design belongs to Sir Joseph Paxton, how much to the contractors, or how much to the subordinate officers employed by the Company. Here, as in a cathedral, every man was set to work in that department which is was supposed he was best qualified to superintend. There was room for every art and for every intellect; and clashing and interference were impossible. This, however, is only the second of the series. A third would probably as far surpass it as it is beyond the first; and if the series were carried to a hundred, with more leisure and a higher aim, we might perhaps learn to despise many things we now so servilely copy, and might create a style surpassing anything that ever went before. We have certainly more wealth, more constructive skill, and more knowledge than our forefathers; and living in the same climate, and being of the same race, there seems no insuperable difficulty in our doing at least as much if not more than they accomplished.

Art, however, will not be regenerated by buildings so ephemeral as Crystal Palaces, or so prosaic as Manchester warehouses, nor by anything so essentially utilitarian as the works of our engineers. The one hope is that, having commenced at the bottom, the true system may extend upwards, and come at last to be applied to our palaces and churches, and the whole nation lend its aid to work out the great problem. Whenever its significance is rightly appreciated by the public, this result seems inevitable; and with the means of diffusing knowledge which we now possess, we may perhaps be permitted to fancy that the dawn is at hand, and that after our long wanderings in the dark, daylight may again enlighten our path and gladden our hearts with the vision of brighter and better things in art than a false system has hitherto enabled us to attain."

With this review of the author's introductory essay, our present remarks must terminate. We purpose, however, resuming the subject in connection with the general history and characteristics which constitute the remainder of the work.

Lithozographia, or Aqua-tinta Stippled Gradations produced upon Drawings Washed or Painted on Stone. By JOSEPH ARES. Imperial 8vo. London: Published by the Author.

This compilation of Mr. Aresti is intended to show the various modes that have been attempted to produce drawings in resemblance of aqua-tinta by some seven or eight lithographers. The late Mr. Hullmandel took a patent out for the process about ten years ago, and there is every reason to presume had he deemed it successful it would have been universally adopted. There were works produced by him by his process, and with some degree of success; but upon examination of the subjects, it could be readily seen that they did not stand in printing, and that stone was not the medium to produce aqua-tinta plates. The art of aqua-tinting on copper, much used before lithography had become universal, has died out because the latter art by the modes practised superseded it; but if aqua-tinta is to be adopted again, we should recommend steel, because certainty of success in effect is obtainable, as well as a long number of impressions. The plates in illustration of the process in the work before us are, throughout, most feeble and powerless, and give only the appearance of a worn out or spoilt lithographic drawing, and at once show such defects in the process that are more than unpleasant to the eye. It is a rule in mechanics that to gain power you must lose time; but by the process under notice we fear that lithographers will only attempt to save time at the expense of power, and every thing else worth striving for.

Improved Bunsen's Lamp.—The above lamp was lately exhibited at the Royal Scottish Society of Arts by Dr. Fergusson, who referred to the inventor, Professor Bunsen, of Heidelberg, and to the modifications which had been made to increase the convenience and power of the lamp. The principle on which the lamp is constructed is, that air mingled with coal-gas, before combustion, causes the flame of the latter to be smokeless. The lamp itself consists of a metal sole, has a gas jet in it communicating with a supply-pipe. Over the jet is a narrow tube for mingling the gas and air, which enters by holes in the tube near the jet, and the mixture burns blue and smokeless above.

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London in the Olden Time; being a Topographical and Historical Memoir of London, Westminster, and Southwark, accompanying a Pictorial Map of the City and its Suburbs, as they existed in the Reign of Henry VIII. before the dissolution of Monasteries: Compiled from ancient documents and other authentic sources. By WILLIAM NEWTON. London: Bell and Daldy. 1855. pp. 120, post-folio.

During the last few years the great metropolis has had more pens and pencils worthily engaged upon its history and illustration than the previous century; we can do no other than imagine that the sweeping removal of whole neighbourhoods for commercial improvements, in the shape of new streets, railway-stations, &c., has done much to call forth the attention of our archæologists, historians, and topographers, to preserve records of all matters of interest they could.

So vast a labour is it to write the history of London, that it would occupy the life of no ordinary gifted person for the task. The truth of our remark is verified by the statements in the recent works of several existing authors: a Cunningham tells us of devoting seven years' anxiety and all his leisure to his Handbook,—a work of great interest and immense research, though perhaps tinctured with inaccuracies and some shortcomings;—a Timbs (a man remarkable for laborious pursuits) of twenty-seven years looking up his "Curiosities," aided by his own and his friends' fifty years' remembrances of changes in the opulent and wide increasing capital. This, like the preceding work, may be deemed a mine of information, and may be consulted with advantage to gain knowledge upon past and present structures, and upon all the celebrities of the city and suburbs. Besides these, there is the large work of Charles Knight; the "Town" of Leigh Hunt; the "London Memorials and Celebrities" of J. Heneage Jesse, and many others, the contents of which are too widely known and estimated to call forth comment from us. But none of the works, from Strype downwards, we are acquainted with, at all occupy the ground now taken up by the attempt of Mr. Newton to set before us mediæval London; and if we read his preface, which states that his large map is based upon the survey of John Rocque, the map of Aggas, 1510, a MS. representation of London, Westminster, and Southwark, in the Bodleian, showing the city and suburbs, by Anthony Van der Wyngrerde; the representation of Hofnagle of Nuremberg, in 1572, and the plan made for the government after the great fire in 1666, there can be but little doubt but that this map possesses in its main features extensive accuracy, and that the sites of the churches, monasteries, royal palaces, bishops' inns, mansions and gardens of the nobility on the banks of the Thames, and the inns of court, are set forth with truth; and though it is scarcely to be expected that every house in the close pent-up streets and alleys are facsimiles in size and shape of the originals, yet we observe that all the numerous large structures are put down with the look and character, whether ecclesiastical, castellated, or palatial, of those that once existed, as well as those that still remain. This can only have been done by ransacking our libraries, and consulting largely every available document. The ancient city wall, of which scarcely a vestige remains, with its gates, barbicans, and external fosse, about which so much has been said, are well laid down; and the conduits, wells, and other water-supply, are also conspicuous. Indeed, this map of the ancient metropolis is well suited to enlighten the historical reader, and illustrate those city romances and legends, based upon events that have taken place in the various localities, the authors of which have attempted so vigorously to describe.

Accompanying the map is a clear and concise historical memoir, principally compiled from Stow and the older historians, giving the origin, rise, and progress of the town, and its topograpical features; and though it is not elaborated to the extent of other histories, yet every event deserving of notice to the time of the eighth Harry is retained, as well as mention made of those rulers, magnates, and wealthy citizens, who contributed so much to advance their city to importance, to provide for its liberties, and promote the well-being of their poorer brethren, by their munificent and unbounded charity.

We look upon Mr. Newton's map and memoir as a most valuable addition to all existing works upon London history, and we think it is calculated to illustrate all. Our readers will do well to supply themselves with it, if they wish to have a clear insight into what London was at the time of the Tudors.

REGISTER OF NEW PATENTS.

COATING IRON WITH ELECTRO DEPOSITS.

FRANCIS PULS, Soho-square, *Patentee*, June 5, 1855.

The invention, which has for its object the coating of iron by a cheap process with zinc in solution, through the medium of the electric current of a galvanic battery, so as to protect the surfaces of the iron from oxidation, and render the said metal more durable and less subject to be injuriously acted upon by atmospheric or other causes, consists in first preparing the iron to be coated by cleansing it in the common way in diluted acids. but leaving the surfaces thereon rough, and therefore better suited for uniting the coating of zinc with the iron, so that the said coating is prevented from peeling or scaling off by rolling, bending, or hammering the metal; therefore, when the iron is taken out of the diluted acid, the patentee washes it only in water with a brush or rag, which method leaves the surfaces of the iron in a rough state, so that the zinc with which it is to be coated can better adhere than by the method at present in use of scouring the iron with sand, &c. He next causes the surfaces of the iron to be submitted continuously to the action of an electric current, which current proceeds from a galvanic battery through the bath in which the articles are to be immersed for the purpose of being coated with zinc, in the manner following (that is to say):—The electric current should in all cases be so regulated that the resistance against the electric current in the bath in which the articles are placed or immersed may be rendered equal or nearly so to that in the battery; to obtain which effect the surfaces of the effective or active sides of the positive plates of the battery should be equal or rather greater than the surface of the articles to be coated, otherwise the deposit of the zinc upon the iron will be but slow and uncertain, and the articles rendered rough and unserviceable.

The patentee is enabled to employ a weak solution of the sulphate or hydrochlorate of zinc, or double or treble salts of the same, with potash, soda, and ammonia, the solution not being required to contain more than from eight to ten per cent. of the salts in proportion to the water, whilst at the same time the exciting fluid in the battery should contain not more than one part of sulphuric or hydrochloric acid to twenty or thirty parts of water, or about equal proportions of hydrochlorate or sulphate of soda, or potash, or ammonia and water. The said solutions are to be changed when the solution in the battery has become saturated with zinc, and the solution in the bath exhausted of zinc by substituting one for the other.

Claims.—The regulating or modulating of the intensity or quantity of the electric current from the battery proportionately to the surfaces of the iron to be coated, thus causing the zinc to be deposited upon the iron in the smallest possible particles or atoms, thereby securing a perfect adhesion of the zinc to the iron.

2. The employment of the cheap salts of zinc above-mentioned, viz., sulphate or hydrochlorate of zinc, or double or treble salts of the same with potash, soda, and ammonia, for the purpose above described.

3. The re-using of the exhausted fluid from the bath in the battery, and that from the battery to the bath.

RAILS FOR RAILWAYS.

JOHN JOSEPH LIEBISCH, London, *Patentee*, June 12, 1855.

The invention consists of making each rail in two or more parts longitudinally, the bottom part having a longitudinal groove for the top part to fit into; or the bottom part may be made in halves to clip the top part, or the top part may have a groove in the under side of it for the bottom part to fit into, so that the top part, on which the principal wear takes place, may be easily taken off and renewed without disturbing the bottom part. The bottom part of the said rails, being laid on either transverse or longitudinal sleepers, may be fastened to them either with or without chairs; but the patentee has no doubt, in practice they will be found unnecessary, as by his arrangements of the parts of which the rail is composed there will never be a joint completely through it, the top parts being so placed as to extend over the joints of the bottom parts, thus forming a solid continuous rail; and in order to prevent the top parts lifting out of the grooves of the bottom parts, the screw bolts, or pins, are put through both parts transversely, and thus the several parts are made into one solid rail.

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These improvements will be clearly understood by reference to the accompanying engravings. Fig. 1 is a section of the rail, showing the top part fitting into a groove in the bottom part; fig. 2, a section showing the bottom part in halves; clipping the top part; and fig. 3, a section showing the bottom parts fitting into

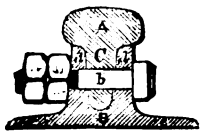


Fig. 1.

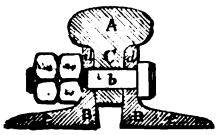


Fig. 2.

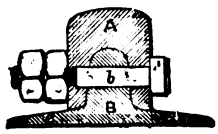


Fig. 3.

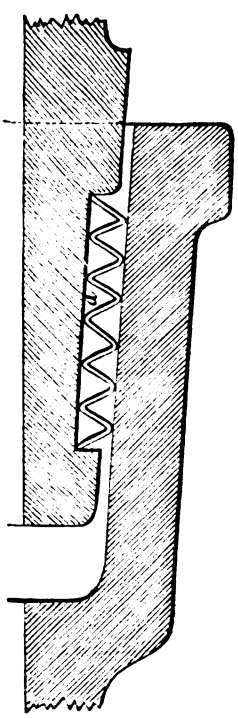
a groove in the under side of the top part. A, represents the top parts of the rail; B, the bottom parts; the web *c*, is made to fit accurately into and between the lips *d*, *d*, of the bottom part. The said lips *d*, *d*, with the flange *e*, form the bottom part of the rail. The parts are fastened together by means of rivets, pins, bolts, and nuts, or similar contrivances, as shown at *b*, in such a manner that for every joint two, four, or more rivets, pins, or bolts are used, whilst the ends of the rails are so arranged, that at every joint of the bottom part of the rail there is a continuation of the top part, and at every joint of the top part there is a continuation of the bottom part, by which a breaking or crossing of the joints is obtained. Rivets, pins, or bolts are also used at certain distances; the top part is made to fit over the web of the bottom part, and secured as already described. The bottom part of the rail is made of angle iron, fixed to the sides of the top part by rivets, pins, or bolts.

It is evident that the improved rail may be used with or without chairs. If used with chairs, the under side of the bottom part must be shaped to suit the chairs; if used without them, the flange of the bottom part may rest directly on the longitudinal or cross sleepers; and to prevent the edges cutting into the sleepers, the bearing flange of the rail is made so broad that the bearing surface of the rail for cross sleepers will be equal to that of a chair; and if used without either sleepers or chairs, the flange of the bottom rail is made large enough to rest directly on the ballast of the roadway.

MAKING THE JOINTS OF PIPES.

JOHN CHARLES PEARCE, Bowling Iron Works, Bradford, *Patentee*, April 20, 1855.

The nature of this invention consists in the use of ring or other shaped packings made of corrugated metal or other material for making steam, air, gas, or water tight joints of pipes and other articles.



The engraving shows the corrugated packing rings marked *a*, applied to an ordinary socket pipe, the socket being made a little taper, so that when the other pipe is driven or forced into it the corrugated ring is compressed, so as to fit closely against the surfaces of both pipes. These rings may be made of various forms to suit particular purposes.

The corrugations may be filled with any suitable cement, such as a composition of ground litharge, Paris white, red lead, fine iron borings, or other ingredients. In some cases, the patentee proposes to combine india-rubber, vulcanised or otherwise prepared with the metal ring, and in other cases gutta-percha or other suitable plastic, yielding, or elastic substance. The corrugated packings may for some purposes be used without cement.

The rings for flat joints may be made in metal dies; a washer of metal or suitable material is placed between the upper and lower die, and on applying pressure to the upper die the corrugations are produced. The rings for circular joints, such as those required for the socket pipes, shown in our engraving, and for other similar purposes, may be formed in corrugated strips, and afterwards bent into a circle, with the ends overlapping a little. The straight strips are applicable to many purposes, and can be readily produced by means of grooved rollers; the flat circular joint rings may also be produced by means of conical grooved rollers. The quality and the thickness of the metal of which the packings are formed must depend upon the dimensions of the packings and the use for which they are to be employed. Iron, copper, tin, zinc, lead, or a mixture of some of these metals may be employed, but the patentee does not confine himself to these metals, as other metals or materials may be used. For some purposes he intends to cast the rings in suitable moulds, so as to produce the required form. When the flanges of the pipes or other articles to which this invention is applied are tightened together, the corrugations of the packings will yield to the surfaces to be jointed; at the same time the corrugations form receptacles for the cement, which is protected from the action of steam or other fluid in the pipes or other articles to be jointed by the inner corrugation.

COMPETITIONS.

The design of Mr. Oliver, jun., has been selected in competition for the new Congregational Church, Middlesbro', Yorkshire.

The design of Mr. Charles Wilson has been selected in competition for the new Free Church College, Glasgow.

The designs of Messrs. Smith and Grundy, of Manchester, for the new Independent Chapel, Toxteth Park, have been accepted. The style is that of the decorated Gothic.

Designs are required for two chapels, with lodges and entrance gates, for a new cemetery, Mansfield, Nottinghamshire. A premium of 7*l*. is offered for the best plan; 5*l*. for the second; and 3*l*. for the third.

APPOINTMENTS.

Mr. Woolrych, late Secretary to the Metropolitan Sewers Commissioners, has been elected Clerk to the Metropolitan Board of Works.

Mr. G. W. Stevenson, late of the firm of Lee and Stevenson, of London, has been appointed engineer to the Borough, and Surveyor to the Local Board of Health, of Halifax. There were fifty-six candidates.

Mr. E. N. Clifton has been appointed Surveyor to the Globe Fire Insurance Company.

Mr. Digby Wyatt has been elected Architect to the East India Company.

Mr. Lovegrove has been elected Surveyor for the Hackney District, under the Metropolis Local Management Act. There were twenty-eight candidates.

Under the Metropolis Local Management Act, a Surveyor is required for the Whitechapel District. Salary 300*l*. Applications to be sent in on or before the 2nd inst.

The Local Board of Health and the Council of Great Yarmouth are desirous of engaging a qualified person to perform the duties of Surveyor. Salary 150*l*. Application must be sent in on or before the 7th inst.

The Local Board of Health of Hastings require a Surveyor. Salary 205*l*. Applications must be sent in on or before the 21st instant.

We are pleased to find Mr. T. Dollman, the author of the excellent work upon "Ancient Pulpits," is busily engaged upon a new work to be devoted to "Examples of Ancient Domestic Architecture," which will consist of forty plates, illustrating, by perspective views, elevations, plans, sections, and details, those interesting structures,—Ford's Hospital, Coventry; the middle pointed Hospital of St. John, Northampton: the entire domestic portion of St. Cross, near Winchester, with its church and other buildings; the Hospital at Ewelme, Oxfordshire; the Bede-Houses, at Stamford and Higham Ferrars; the Earl of Leicester's Almshouses at Warwick; and some others. By the specimens of the plates we have seen, we feel assured this volume will be considered well timed, and can do no other than prove valuable to the profession, who are engaged in the erection of buildings either for educational or charitable institutions; whilst the moderateness of its price will bring it within the reach of every student.

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ARCHITECTURE IN LIVERPOOL.

WAR and its accompaniments of high taxes and slack trade, appear to have little effect in retarding our town improvements, which (says the *Liverpool Albion*) are at present progressing with a degree of energy sufficient to gratify the most ardent advocates for the extension of street architecture, and which, when completed, will add most materially to the appearance of the "good old town." In Water-street, the old dingy offices, formerly occupied by the Cunard Company, and Messrs. Bailey Brothers' iron warehouses, are being pulled down, and when handsome suites of offices are erected on their sites, few thoroughfares in any English town will be adorned with handsomer or more stately buildings devoted solely to mercantile purposes. In Dale-street operations have already commenced for pulling down the old Gas-offices and the condemned "block" on the opposite side of the street; while in High-street, Exchange, the old Police-offices, and the offices and shops contiguous to them are marked off for sale. They will be sold in ten lots, in the course of the present month, by Messrs. Winstanley, the shops occupied by Mr. Lea and Mr. Bird, and the offices by Messrs. H. Davies and Co., being left standing till June next. On the site of these buildings the owners of the property, the Liverpool and London Fire and Life Insurance Company, intend erecting a handsome suite of offices, uniform with the Town-hall and the Exchange-buildings, which will be designed by Professor Cockerell, the architect of the Bank of England, in Castle-street. The exact plans of this building are not yet settled, but Mr. Swinton Boult, the Secretary to the Company, is at present in London conferring with the architect about them. The whole of the above-mentioned buildings are expected to be completed within the next two years.

IMPROVED STANDARD WEIGHT.

Mr. E. Sang, F.R.S.E., lately exhibited, at the Royal Society of Arts, a standard pound weight, which he had constructed some twenty years ago. It consisted of a quantity of mercury contained in a strong glass ball, the neck of which was closed by fusion. The advantages of this kind of standard were stated to be *density, hardness, and resistance to chemical change.* But the most important quality which it was said to possess is this, that any wear caused by frequent use, or any wilful reduction in its weight, must be accompanied by a change in its specific gravity; and that, thus, a comparison of its specific gravity at any time with its original specific gravity would afford data from which to compute the loss of weight.

NEW PATENTS.

PROVISIONAL PROTECTIONS GRANTED UNDER THE PATENT LAW AMENDMENT ACT.

Dated August 29.

1951. C. P. Rosson, Manchester—Improvements in machinery or apparatus employed for dressing and finishing textile fabrics, by the application of a new material, in the place of hogs' bristles or wire-cards hitherto employed therein

Dated September 6.

2018. C. Pryse, Birmingham, and P. Cashmore, West Bromwich, Stafford—Improvements in repeating fire-arms

Dated October 2.

2197. W. Horton, Birmingham—Improvements in the breech part of fire-arms

Dated October 18.

2336. S. Statham, Islington—Improvements in electric telegraph cables

Dated November 9.

2520. J. Olive and W. Olive, Woolfold, near Bury, Lancaster—Improvements in the manufacture of wheels for railway and other purposes

Dated November 13.

2550. R. Tempest, J. Tomlinson, R. Hampson and J. Hampson, Rochdale, Lancaster—Improvements in looms for weaving, which improvements are applicable to working the valves of steam-engines.

Dated November 16.

2584. W. Cooke, Frederick-street, Gray's-inn-road—An improved apparatus for cleaning knives and other cutlery

Dated November 17.

2596. J. Shaw, New King-street, Hull—Improvements in the prevention of accidents arising from collisions on railways

Dated November 19.

2599. T. Culpin, Royal-hill, Greenwich—An improved apparatus for regulating the supply and discharge of fluids and gases

2601. J. Pratt, Bath-street, City-road, and T. Radcliffe, Shaftesbury-street, Hoxton—Improvements in the manufacture of brushes

2603 J. Silvester, West Bromwich, Stafford—Improvements in steam-gauges and safety-valves

2605. J. McNicol, Manchester—Improvements in machine or cylinder printing

2607. M. P. A. Gilardeau, Rue de l'Echiquier, Paris—A new motive power

Dated November 20.

2609. T. Schwartz, New York—Improvements in drying, heating, and melting solid and plastic bodies

2611. G. Geyelin, Melville-terrace, Camden-road—Propelling vessels by means of pistons, which he calls anti-friction propellers, to supersede paddle-wheels, screws, and all other contrivances at present in use

2613. F. Puls, Soho-square—A new electric light and heat

2615. P. A. Lecomte de Fontainemoreau, South-street, Finsbury—Improvements in apparatus for preventing horses from running away. (Communication)

2617. E. O. W. Whitehouse, Brighton—Improvements in electro-telegraphic apparatus, parts of which are also applicable to other purposes

2619. D. S. Price, South Moulton-street, and E. C. Nicholson, Newington-crescent—Improvements in the manufacture of cast-steel

2621. G. S. Tolson, R. H. Tolson, and J. S. Tolson, Dalton, York, and T. Irving, Moldgreen, Dalton—Improvements in producing metallic lustre to yarns and fabrics. (Communication)

Dated November 21.

2624. W. Cooke, Frederick-street, Gray's-inn-road—Improvements in gas and solar light reflectors

2525. A. J. B. L. de Marchesheau, Paris—Improvements calculated to increase the efficiency or working power of steam-engines

2627. W. Munslow, and H. Wallwork, Miles Platting, Lancaster—Improvements in railways

2629. T. W. G. Treeby, Westbourne-terrace-villa, Paddington—Improvements in revolving fire-arms

Dated November 22.

2631. J. Roberts, jun., Whitechapel-road—A machine or apparatus for cooling tobacco during the process of manufacture

2633. E. Calvert, and S. A. Smith, Walton-le-Dale, Lancaster—Improvements applicable to carding-engines

2636. F. Lotteri, Bergamo, Lombardy—Obtaining fibre from the bark of trees of the Morus family or class, and the application thereof to the manufacture of paper and textile materials, and for other useful purposes

2637. C. T. Dunlop, Glasgow—Improvements in the manufacture or production of artificial oxide of manganese

2639. C. May, Great George-street, Westminster, and P. Prince, Derby—Improvements in the manufacture of spikes and trenails

Dated November 23.

2643. J. H. Hutchinson, East Retford, Nottingham—Improved machinery for converting rectilinear motion into rotary motion

2645. J. Jobson, Litchurch, Derby—Improvements in the manufacture of railway-chairs

Dated November 24.

2649. J. Lobstein, Paris—Improvements in sewing-machines

2651. R. Knowles, Chorlton-upon-Medlock, Lancaster—Improvements in winding on in certain machines for spinning cotton and other fibrous materials

2653. C. Sanderson, Sheffield—An improvement in the manufacture of iron

Dated November 26.

2655. L. J. F. Margueritte, Paris—Improvements in precipitating certain salts

2656. D. Jonquet, Mina-road, Old Kent-road—Improvements in the blades of mechanical cutting machines, and in the blades of single or double-handled cutting instruments, and in blades of ordinary and mechanical shears and scissors, and in the handles and springs for the same

2657. J. Wilkes, Birmingham—An improvement or improvements in the manufacture of tubes of copper and alloys of copper

2659. F. Coignet, Rue Hauteville, Paris—Improvements in the use and preparation of plastic materials or composition to be used as artificial stone, or as concrete or cement for building and other purposes

2661. F. Osbourn, Aldersgate-street—Improved machinery for pressing, smoothing, or finishing garments or parts of garments

2662. J. J. C. de Clerville, Newman-street, Oxford-street—Improvements in preparing oil with other matters, for painting. (Communication from F. Abate, Paris)

2665. R. Bell, Glassford-street, Glasgow—Improvements in the manufacture of woven fabrics when made of wool and cotton, or of wool, cotton, and silk

Dated November 27.

2667. W. E. Newton, Chancery-lane—Improvements in breech-loading fire-arms. (Communication

2669. H. Hyde, Truro, Nova Scotia—An improved manufacture of lubricating oil. (Communication)

2671. C. Rice, Massachusetts, U. S.—A new or improved method of manufacturing boots and shoes. (Communication from H. G. Tyer and J. Helm, New Jersey, U.S.)

2673. C. Rice, Massachusetts, U. S.—A new or improved process of preparing cloth so as to render it nearly, if not entirely, impervious to water, but not so to air, such cloth being particularly useful in the manufacture of boots and shoes, or various other articles of dress or utility. (Communication from H. G. Tyer and J. Helm, New Jersey, U. S.)

2675. G. L. Stott, St. George's, Gloucester—Improvements in the manufacture of carbonate of soda

2677. J. H. Johnson, Lincoln's-inn-fields—Improvements in windlasses, capstans, and other purchases, parts of which are applicable to the transmission of motive power. (Communication from L. F. F. Davio, Havre, France)

2679. J. H. Johnson, Lincoln's-inn-fields—Improvements in the manufacture or preparation of india-rubber and gutta-percha, and in the applications thereof. (Communication from H. V. Wacrenier, Paris)

2681. G. Richardson, Craig's-court, Charing-cross—Improvements in chain cables and other chains. (Communication)

Dated November 28.

2683. C. J. B. Barbier, Paris—Improved kiln for burning or firing pottery, bricks, tiles, and other earthenware

2685. B. Rosenberg, New Charles-street, City-road—Improvements in protecting metallic and other surfaces from corrosion and decay. (Communication)

2687. R. A. Brooman, Fleet-street—Improvements in the manufacture of sand, emery, and glass papers, and in the machinery employed therein. (Communication)

2689. S. Wolff, Independence, Missouri, U.S.—Improvements in obtaining motive power

2690. J. Walker, Leeds—Improvements in the manufacture of textile fabrics

2691. C. Clarke, Farm-lane, Walham-green, Fulham—Improvements in applying roughings to the feet of horses

Dated November 29.

2693. T. Symons, Flushing, Cornwall—Improvements in the permanent ways of railways, and in the wheels rolling thereon

2696. C. M. Archer, St. James's-gardens and Haverstock-hill—A new material for the manufacture of paper

2697. A. V. Newton, Chancery-lane—An improved process of manufacturing hats. (Communication)

2698. G. North, Lewisham-road, Greenwich—Improved portable apparatus for supporting and folding heads, tilts, coverings, and awnings of wheel-carriages, marine vessels, goods and ways

2699. P. L. Bergeon, Paris—Improved spitting-box or spittoon. (Communication)

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Dated November 30.

2701. H. T. Humphreys and J. Loughry, Kilmacow Mills, Waterford—Improvements in machinery or apparatus for cleaning wheat
2703. A. Dusautoy, Boulevart des Italiens, Paris—New and useful machinery for cutting cloth and other substances
2705. E. J. Davis, West Smithfield—Improvements in preparing food for horses and other animals

Dated December 1.

2707. E. A. Pontifex, Shoe-lane—Improvements in furnaces
2709. W. Needham and J. Kite, Vauxhall—Improvements in machinery or apparatus for expressing liquids or moisture from substances
2710. J. Gardner, Mortimer-street, Cavendish-square—A method of treating tea for economising its use and transport
2713. W. A. Woodley, Taunton—Improvements in the manufacture of paper bags

Dated December 3.

2715. D. Anderson, Strandtown-house, Down, Ireland—Improvements in machinery or apparatus for the preparation or manufacture of felt and other fibrous materials
2719. W. Rowan, firm of J. Rowan and Sons, Belfast—Improvements in steam-engines
2721. A. Watt, Dean-street, Soho—Improvement in coating iron and steel with zinc

Dated December 4.

2723. S. Garn, Sevenhampton, Wiltshire,—Improved tipping apparatus applicable to carts and other vehicles
2724. E. A. N. Brécheux, Paris—Improved axletree for carriages
2726. W. Foot, Wellington, Somerset—Instrument for moving and stopping trucks and other carriages on railways
2727. J. Barling, High-street, Maidstone—Improvement in the manufacture of paper by the application of a root not before used for the purpose
2728. J. Davoust, Paris—Improvements in cartridges. (Communication)
2729. W. Knight, St. Marylebone—Improved mode of cutting out or shaping materials to be employed in making over-coats or other similar articles of dress
2730. J. Marsh, Nottingham—Improvements in the manufacture of looped and pile fabrics

Dated December 5.

2731. A. Bullough, Blackburn—Improved lubricator for looms
2732. J. Moffatt, Birmingham—Improvement or improvements in the manufacture of metallic spoons, forks, and ladles
2733. W. G. Plunkett, Belvidere-place, Dublin, and J. Bower, Lower Ormond-quay, Dublin—The manufacture of fibres or threads for textile fabrics and cordage, also of paper, mill-board, and other similar boards from plants or portions of plants not hitherto used for these purposes
2634. W. Nunn, Church-street, Hackney—Improved table, washstand, mirror, &c., combined in one piece of furniture
2736. W. Beatson, Rotherham—Improvements in treating borates of lime and magnesia, and a new composition formed therewith, suitable for glazing and other purposes for which borax has been or may be employed
2737. C. Heilmann, Milk-street, Cheapside—Improvements in grates or furnaces for steam-boilers
2738. W. Smith, Margaret-street, Cavendish-square—The improvements in apparatus for regulating the supply of air to furnaces
2739. W. H. Smith, Wellington-chambers, Cannon-street West—An improved construction of fastening, applicable to gaiters, stays, and other like articles
2740. A. V. Newton, Chancery-lane—Improvements in apparatus for dressing cloth. (Communication from N. d'Argence)

Dated December 6.

2741. J. Marland and S. Marland, Sun Vale Iron Works, Walsden, Lancaster—Improvements in power-looms
2744. W. Mosley, Salford, Lancaster—Improvements in machinery or apparatus for stretching and finishing woven fabrics
2743. W. G. Wilson, Penton-cottage, Penton-place, Newington Butts—A pneumatic moderator
2745. A. Paget, Loughborough, Leicester—Improvements in machinery or apparatus for the manufacture of looped or other fabrics
2746. J. Barrow, jun., Manchester—Improved process of manufacturing soda and sulphuric acid
2748. T. Dunn, Glasgow—Improvements in fire-arms
2749. J. Rock, jun., Hastings, Sussex—Improvements in the construction of tents, huts, and portable buildings
2750. J. Cornes, Swan-lane—Improved mangle or press, parts of which are applicable to rollers employed for pressure purposes generally
2751. T. Chaffer, Liverpool, and J. Ellis, Vulcan Foundry, near Warrington—Improvements in machinery for sawing and cutting slate, stone, coal, salt rock, or other minerals
2752. J. Neuenschwander, Berne, Switzerland—Improvements in the process of preparing what is called "Swiss whey," from milk
2753. R. Bodmer, Thavies-inn—Improved planimeter. (Communication from J. Amsler, Schaffausen, Switzerland)
2754. T. R. Crampton, Adelphi—Improvement in furnaces and in apparatus for supplying fuel thereto
2755. A. M. Perkins, Francis-street, Gray's-inn-road—Improvements in apparatus for generating steam
2756. F. S. Thomas and W. E. Tilley, Kirby street—Improvements in producing aluminium and its alloys, and in plating or coating metals with aluminium and alloys composed of aluminium and other metals
2757. A. M. Perkins, Francis-street, Gray's-inn-road—Improvements in warming buildings and apartments by hot water

Dated December 7.

2750. A. Latta, Metz, France—Preparing gutta percha in combination with other substances, applicable to various purposes
2758. J. J. E. F. Kuister, Lyons—Improvements in raw silk winding machinery
2760. H. Hart, Waterloo-crescent, Dover—A ship leakage indicator. (A communication)
2761. D. Dick, Paisley, Scotland—Improvements in machinery to be used in finishing cloth and textile fabrics
2762. J. Gardner, Plaistow, H. Gardner, and J. C. Gardner, Leytonstone-road, Essex,—Improvements in glasses as applied for the transmission of light
2763. H. Cranston, Coronation-street, Sunderland—An improved method of manufacturing lozenges
2764. C. Lenny, Croydon—Improvements in carriages
2766. J. A. Williams, Baydon, Wilts—Improvements in machinery or apparatus for cultivating land
2767. J. Leitch, Ellenborough-street, Liverpool—Improvements in melting, blowing up, and filtering sugars and other saccharine matters
2768. H. Bessemer, Queen-street-place, New Cannon-street—Improvements in the manufacture of iron
2769. J. Gray, Strand-street, Liverpool—Improvements in azimuth and amplitude instruments
2770. C. E. Green, Blandford-street, Portman-square—Improvements in huts, tents, and camp hospitals
2771. H. J. Van den Hout, and E. Brown, Kentish-town—Improvements in utilising leather shavings

Dated December 8.

2772. J. Hacking, Bury, Lancaster—Improvements in machinery for supplying fuel and air to furnaces
2773. C. F. J. Fonrobert, Berlin—An artificial leech and a sucker
2774. J. Radcliffe, and T. V. Favell, Rotherham, York—Improvements in machinery or apparatus for cutting sugar and other substances
2775. W. Norton, Kirkburton, York—Improvements in weaving pile fabrics
2776. A. Tevindale, Wellington-buildings, Liverpool—Improvements in propelling, and in the construction of steam and other vessels
2777. F. Devos, Rue Drouot, Paris—Improvements in preparing and tanning hides and skins
2778. A. Maclure, Walbrook—Improvements in lithographic printing-presses

Dated December 10.

2779. J. Wrigley and J. Norcliffe, Oldham, Lancaster—Improvements in shuttles, and in the method of using the same
2780. J. Hall, jun., Mount Pleasant, Walmersley, Lancaster—Improvements in jacquard looms
2781. J. Cocker, Liverpool—Improvements in the manufacture of wire
2782. T. Heppleston and J. Hunter, Manchester—Improvement in machinery or apparatus for stretching and finishing yarns or threads
2783. J. H. Johnson, Lincoln's-inn-fields—Improvements in the manufacture of safety-paper. (Communication from V. Courboulay, Place du Caire, Paris)
2784. D. Parsons, Pensnett, near Dudley—Improved break for arresting or retarding at will the motion of locomotive and other engines and revolving machinery
2786. R. A. Brooman, Fleet-street—Improvements in manufacturing gas from peat, and in treating hydrogen gas, in order to render it illuminating. (Communication from C. M. I. de Flers, Paris)
2787. J. G. Jennings, Great Charlotte-street, Blackfriars-road—Improvement in the arrangement of the over-flow pipes of baths, wash-hand basins, and other vessels
2788. J. G. Jennings, Great Charlotte-street, Blackfriars-road—Improvements in connecting earthenware rain pipes, and soil-pipes of water-closets, and in valve water-closets
2789. J. G. Jennings, Great Charlotte-street, Blackfriars-road—Improvement in the rising pipe and suction-valves of pumps

Dated December 11.

2790. B. Hughes, Rochester, New York—A machine for making spokes and tool handles. (Communication)
2791. B. Hughes, Rochester, New York—A knot-tying sewing-machine. (Communication)
2793. J. M. Prêaud, Lyons, France—Improvements in india-rubber springs
2794. A. Tolhausen, Duke-street, Adelphi—Improvements in mariners' and land compasses. (Communication from J. Prime, Washington, U.S.)
2796. J. Cliff, Burton-on-Trent, Stafford—Improvements in or additions to furnaces
2797. J. H. Johnson, Lincoln's-inn-fields—An improved apparatus for discovering the leakage or escape of gas. (Communication from E. A. Macaud, Paris)
2798. R. Levy, Manchester—Improvement in wearing apparel
2799. R. A. Whytlaw and J. Steven, Glasgow—Improvements in weaving
2800. R. S. Bouët, and H. E. I. Douein, Paris—Improvements in the preservation of meat and other animal substances serving for food
2801. A. V. Newton, Chancery-lane—Improved machinery for manufactnring bolts. (Communication)
2802. A. Forot, Paris—Improvements in parasols
2803. S. Clarke, Albany-street, Regent's-park—Improvements in lanterns for affording light, and for cooking
2804. R. Ruding, Bunhill-row—Improvement in printing silks and other woven fabrics with gold and other metal leaf or powder

Dated December 12.

2806. M. Billing and W. G. Whitehead, Birmingham—A new or improved waterproof fabric or material
2807. I. Beardsell, Huddersfield—Improvements in the finishing of mohair cloths and other textile fabrics, and in the machinery employed for that purpose
2808. G. H. Hay and D. S. Hay, Edinburgh—Improvements in photographic pictures
2809. R. Midgley, Salterlee Mill, Halifax, and G. Collier, Halifax—Improvements in preparing worsted, mohair, alpaca, cotton and other yarns
2810. W. Leighton, Newcastle-upon-Tyne—Improvements in paddle-wheels
2811. R. Holben, Barton, Cambridgeshire—Improvements in apparatus for chapping barley
2812. T. Rickett, Stony Stratford, Buckingham—Improvements in pressure-gauges

Dated December 13.

2813. J. Roberts, Falmouth—Improvements in machinery for moulding bricks and tiles
2814. D. Hart, Trinity-square—Improvements in signalling and communicating between parts of a railway train, and in the instruments and apparatus employed for such purpose
2815. A. L. Poitevin, Paris—Improved photographic printing
2816. A. L. Poitevin, Paris—Improved photographic engraving
2817. J. Murdoch, Staple-inn, Middlesex—A process for separating the oleine from the stearine of fatty and oleaginous bodies, and for the extraction of oil from oleaginous grains and from olives. (Communication)
2818. G. Skelton, Lambeth—An improved projectile
2819. J. Little, Glasgow—Improvements in heating and cooking apparatus
2820. J. H. Johnson, Lincoln's-inn-fields—Improvements in apparatus for containing and distributing aeriform fluids under pressure. (Communication from J. Cockerill, Seraing, Belgium)
2821. J. H. Johnson, Lincoln's-inn-fields—Improvements in apparatus for containing compressed air or gases, and in the application of the same to the obtainment of motive power. (Communication from J. Cockerill, Seraing, Belgium)
2822. G. H. Nicoll, Dundee—Improvements in fire-places or heating apparatus

Dated December 14.

2823. J. W. Friend, Fremantle, Southampton—Improved registering log and deep sea lead
2824. W. Philippi, Regent-street—Improvements in coating iron with tin
2825. A. Krupp, Essen, Prussia—Improvements in railway and other wheels, and in the method of, and machinery for manufacturing the same
2826. G. T. Bousfield, Sussex-place, Loughborough-road—Improvements in machinery for the manufacture of cut pile fabrics. (Communication)
2827. C. J. Todd and R. Pinkney, Long-acre—A balance pen
2828. F. O. W. Whitehouse, Brighton—Improvements in apparatus for measuring fluids
2829. P. Hayworth, Manchester, and A. Forrest, Birmingham—Improvement in the manufacture of belts, bands, braces, and other similar articles of wearing apparel

Dated December 15.

2830. W. H. Newman, Cannon-street-road—Improved fire-lighter
2831. L. Clayton, Unsworth, Lancaster—Improvements in machinery for dressing yarn
2832. T. Warren, Glasgow—Improvements in the manufacture and moulding or shaping of glass
2833. J. Aspinall, Limehouse—Improvements in machinery for curing sugar and extracting moisture therefrom, parts of which are applicable to separating liquids and moisture from substances containing the same

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2834. E. B. Hutchinson, Moorgate-street—Improved apparatus for forming and cutting elliptical figures
2837. A. Wallace and J. Wallace, Nether-place Bleach Works, Renfrew—Improvements in bleaching, washing, or cleansing textile fabrics and materials
2839. W. Clay, Liverpool—Improvements in the manufacture of bar iron
2840. S. Stewart, Clement's-lane—Improved combined engine and gas exhauster, and also improvements in the valves of such exhausters
2841. W. Clay, Liverpool—Improvements in the manufacture of iron and steel
2842. P. M. Salomon, Rue Neuve, St. Eustache, J. L. Montgazan, Rue de Bondy, and C. M. J. de Flers, Rue Lafitte, Paris—Improvements in the manufacture of gas from coals, and in the production of bituminous coke in that manufacture, and also in the apparatus connected therewith

Dated December 17.

2843. S. F. Cottam, Manchester—Improvements in mules for spinning cotton and other fibrous materials
2844. G. Collier and J. Crossley, Halifax, and J. W. Crossley, Brighouse, Halifax—Improvements in apparatus employed in drying and stretching woven fabrics
2845. C. Bracegirdle, Congleton, Chester—Improvements in the manufacture of bolting cloths employed in dressing flour
2846. H. Stewart, Baker-street—Machine or apparatus for cleaning and polishing forks, spoons, and other like curved articles
2847. J. L. Jeffree, Blackwall—Improvements in or additions to furnaces
2848. O. C. Evans, New York, U.S.—Improvements in digging-machinery
2849. F. W. East, Bermondsey-street—Improvements in waterproofing and enamelling textile and other fabrics, in imitation of and to be used in lieu of leather, and for other similar purposes
2850. G. G. Golding, Messrs. W. Cubitt and Co's, Gray's-inn-road—Improvements in boilers for heating, warming, or raising steam
2851. W. Sangster, Cheapside—Improvements in the manufacture of stays and corsets
2852. J. Leitch, Ellenborough-street, Liverpool—Improvements in filtering sugars and other saccharine matters
2853. W. Hemsley, Melbourne, Derby—Improvement in the manufacture of elastic pile fabrics
2854. J. J. Fontaine, Paris—Improvements in the manufacture of steel
2855. J. H. Johnson, Lincoln's-inn-fields—Improvements in ships' tillers. (Communication from L. F. F. David, Havre)
2856. A. Small, Glasgow—Improvements in marine compasses, and in apparatus applicable thereto
2857. W. Wilkinson, Nottingham—Improvements in machinery employed in the manufacture of looped fabrics

Dated December 18.

2858. C. R. Wessel, Fitzroy-square, New-road, and G. Bowden, Little Queen-street, High Holborn—Joining elastic webbing into indissoluble bands
2859. A. Tolhausen, Duke-street, Adelphi—Improved harvesting machine. (Communication from D. C. Henderson, and A. H. Caryl, Sandusky, Ohio, U.S.)
2860. J. P. Humaston, Newhaven, U.S.—Improvements in instruments for composing and transmitting telegraph messages
2861. C. Nickels, Albany-road, Surrey, and J. Hobson, Leicester—Improvements in the manufacture of pile fabrics
2862. D. L. Price, Beaufort, Brecknock—Improvements in electric telegraphs, and in appliances connected therewith as applied to railway trains and fixed stations
2863. A. V. Newton, Chancery-lane—An improved mode of manufacturing wrought-iron cannon. (Communication)
2864. H. Hyde, Truro, Nova Scotia—Improved mode of purifying alcohol or alcholic spirits. (Communication)
2865. A. V. Newton, Chancery-lane—Improvements in washing-machines. (Communication)
2866. E. Davies, and J. M. Syers, Liverpool, and C. Humfrey, Camberwell—Improvements in distilling resinous, bituminous, fatty and oily matters, and in the treatment of certain products therefrom
2867. F. R. A. Glover, Bury-street, St. James—An improved instrument or apparatus for taking angles and measuring lines, surfaces, and solids, and ascertaining the variation of the needle
2868. F. R. A. Glover, Bury-street, St. James—Improvements in the construction of break-waters, sea-walls, and other structures or foundations of structures which lie partially or entirely under water

Dated December 19.

2869. J. Cartwright, Hyde, Chester—Improvements in taps or valves
2870. G. Ross, and T. Wilkes, Birmingham—New or improved machinery for the manufacture of bolts, rivets, spikes, screw-blanks, screws, nuts for screws, and washers
2871. R. Ruston, Birmingham—Improvements in the construction of anchors, and appendages to be used therewith
2872. J. Hadden, H. Hadden, F. J. Hadden, and C. S. Hadden, Nottingham—Improvements in circular frames for the manufacture of ribbed fabrics
2873. J. Sanders, Bristol—Improvements in trusses for supporting parts of the human body
2874. H. R. Abraham, Howard-street, Strand—Improvements in carriages, and in certain appurtenances and appendages which belong to those used as hospital conveyances or ambulances
2875. G. Harvey, Charlotte-street, Portland-place—Improvements in portfolios

Dated December 20.

2876. R. Walker, Eccleston, near Prescot—Improvements in applying power to, and in machinery for raising and lowering coals, and other articles from and into mines
2877. R. W. Sievier, Upper Holloway—Improvements in guns and pieces of ordnance, and the projectiles thrown from them for the purposes of war
2878. A. Shanks, Robert-street, Adelphi—Improvements in instruments for indicating pressures
2879. J. Fleming, jun., Newlands-fields, Renfrew—Improvements in bleaching, washing, cleansing, and preparing textile fabrics and materials
2881. E. Evans, South Wales—Improvements in combining and fixing railway-bars
2882. G. T. Bousfield, Sussex-place, Loughborough-road, Brixton—Improvements in machinery for splitting leather. (Communication)
2883. P. Antrobus, Chepstow—Improvements in preserving and packing flour
2884. J. Barcroft, Hanley, Stafford—An improvement in the materials to be used in the manufacture of baskets and basket-work
2885. A. C. L. Devaux, King William-street—Improved machinery for crushing and grinding vegetable and other substances
2886. L. R. Bodmer, Thavies-inn—Improvements in hydraulic seed-crushing machines or oil-presses

Dated December 21.

2887. D. D. Kyle, Albany-street, Regent's-park—A method of communicating motion
2888. J. B. E. Saffroy, Bordeaux—An improved break for railway-carriages. (Communication)
2889. J. Watson, Glasgow—Improvements in the manufacture or production of articles of ladies' dress
2890. T. E. Merritt, Maidstone—Improvements in breech-loading ordnance and fire-arms
2891. B. Hughes, Rochester, New York, U.S.—A mode of mingling the vapour of bisulphuret of carbon and steam, and applying them as a motive power
2892. M. Tomlinson, Ivy-house, Culcheth, Lancaster—An improved medical plaister
2893. C. J. Appleton, Manchester—Improvements in machinery or apparatus for knitting. (Communication from J. Pepper, Franklin, U.S.)
2894. J. Murdoch, Staple-inn—Improvements in machines or apparatus for working chain stitch embroidery. (Communication)
2895. E. Tyer, Cornhill — Improvements in telegraphing or communicating by means of electricity
2896. H. Francis, West Strand—Improvements in apparatus for cutting out parts of garments
2897. C. Glover, Lincoln—Removing snow from a line of railway
2898. W. J. Curtis, Sebbon-street, Islington—Improvements in fog-signals, and in laying the same upon the rails of railways

Dated December 22.

2900. M. Kennedy, Ulverstone, Lancaster, and T. Eystwood, Preston—Improvements in pump-buckets, which improvements are also applicable to lift-pumps, air-pumps, and all similar apparatus
2902. J. H. Johnson, Lincoln's-inn-fields—Improvements in furnaces for steam-boilers and other heating purposes. (Communication)
2904. C. Dresser, Waterloo-cottage, Hammersmith—Improvements in the mode of effecting what is called "Nature printing"
2906. E. Rowcliffe, Gloucester-terrace, Blackheath—Improvements in the manufacture of blocks or slabs for paving or building purposes
2908. D. Dick, Paisley—A new and improved regulator for gas

Dated December 24.

2910. F. Holdway, Mount-street, Grosvenor-square—Improvements in carriages and various parts of the same
2912. T. Cowburn and G. W. Muir, Manchester—Improvements in steam-boilers, and in valves and parts connected therewith
2914. C. E. Offhaus, Newark, New Jersey, U. S.—Improvements in rotary steam-engines
2916. J. Barton, Stockport—Improvements in shuttles or shuttle-tongues

Dated December 26.

2918. A. Tolhausen, Duke-street—Improvements in railway axle-boxes. (Communication from G. W. and T. C. Geisendorff, U. S.)
2920. J. W. Lewis, Manchester—An improved picker for looms
2922. S. Sawyer, Massachusetts, U. S.—An improved bomb-shell
2924. D. M'Cullum, Victoria-place, Stonehouse, Devon — Improvements in electric telegraphs

Dated December 26.

2926. S. Petit, Versailles—A new or improved apparatus for buoying ships or vessels and also drawing them out of water
2928. A. Krupp, Essen, Prussia—Improvements in gun and gun-carriages
2930. E. Ladmore, Birmingham—A new or improved method of securing ramrods to military fire-arms
2932. J. Grist, Islington—Improvements in machinery for the manufacture of staves and parts of casks, and for forming them into casks, barrels, and other like vessels

Dated December 28.

2934. J. Robinson, R. Cunliffe and J. A. Collet, Manchester—Improvements in locomotive steam-engines, and in springs for locomotive steam-engines and other purposes
2936. T. F. Uttley, Mytholm Royd, York—Improvements in the mode of applying fusible plugs to steam-boilers
2938. G. Chisholm, St. John's-square, Clerkenwell—Improvements in the manufacture of artificial manure
2940. H. G. Bailey, the Vicarage, Swindon, Wilts—Improvements in machinery for digging and forking land

Dated December 29.

2942. L. Harrop, S. Barlow, and A. Boyd, Oldham, Lancaster—Improvements in self-acting mules for spinning and doubling cotton and other fibrous materials
2944. A. Ford, Park-lodge, New-road, Hammersmith—Preparing and dissolving in naptha or oil of turpentine vulcanised india-rubber, for the purpose of water-proofing, and all or any of the other purposes for which the same, not so prepared and dissolved, is now applicable
2946. W. Lange, Tachbrook-street—Improvements in biscuit-ovens. (Communication from J. Lange, Altona, near Hamburg)
2948. G. R. Birch, Paddington—A form and folding desk combined, adapted for the use of schools
2950. T. Holmes, Hull—An improvement in the manufacture of driving straps or bands for machinery

Dated December 31.

2954. J. Salter, Manchester—Improvements in apparatus for promoting the draught in chimneys, and for ventilating apartments
2956. A. Turner, Leicester—Improvements in the manufacture of looped fabrics
2958. G. H. Cottam, St. Pancras Ironworks, Old Pancras-road—Improvements in applying detonating or exploding signals on the rails of railways

Dated January 1, 1856.

2. F. Swift, Brompton row, Brompton—Improvements in carriage-wheels and axles, and in vehicles for common roads
4. A. V. Newton, Chancery-lane—A novel system of propulsion, applicable to land and water. (Communication from F. Garnier, Clermont Ferrand, France)
6. A. Cochrane, Eaton-terrace, St. John's-wood—Improvements in collecting and distributing water and alluvial deposits contained in sewage and other water

Dated January 2.

10. R. A. Tilghman, Philadelphia, U.S.—Improvements in the manufacture of iron
12. H. L. Sellers and J. L. Talbott, Cincinati, Ohio, U.S.—Improved apparatus for measuring and weighing grain, seeds and other substances. (Communication)

Dated January 3.

14. F. Haines, Lime-street—The deadening of the sound and the prevention of vibration and concussion in connection with machinery, gun, and mortar-boats, and general ordnance, and other purposes
16. G. Williams, Cannon-street East—Improvements in the construction of waterclosets for ships
18. W. A. Distin, Cranbourne-street, Leicester-square—Improvements in pipes for smoking
22. J. H. Johnson, Lincoln's-inn-fields—Improvements in apparatus or means for facilitating the performance of church and other music on organs, harmoniums, pianos, and other similar keyed musical instruments. (Communication from F. Guichnené
24. J. H. Johnson, Lincoln's-inn-fields—Improvements in breechloading fire-arms. (Communication from C. A. Friedrich, Stettin, Switzerland)
26. J. F. Lackersteen, Young-street, Kensington-square—Improvements in the prevention of collisions on railways
28. C. Marsden, Kingsland-road—Improvements in the ventilation of sewers, tunnels, mines, and other confined places

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PATENTS APPLIED FOR WITH COMPLETE SPECIFICATION.

2835. E. Rogers, Abercarn, Monmouth—Improvements in safety doors for mines—December 15
2880. D. S. Porteous, Paisley—Regulating the pressure of gas, steam, water, or other fluids—December 20

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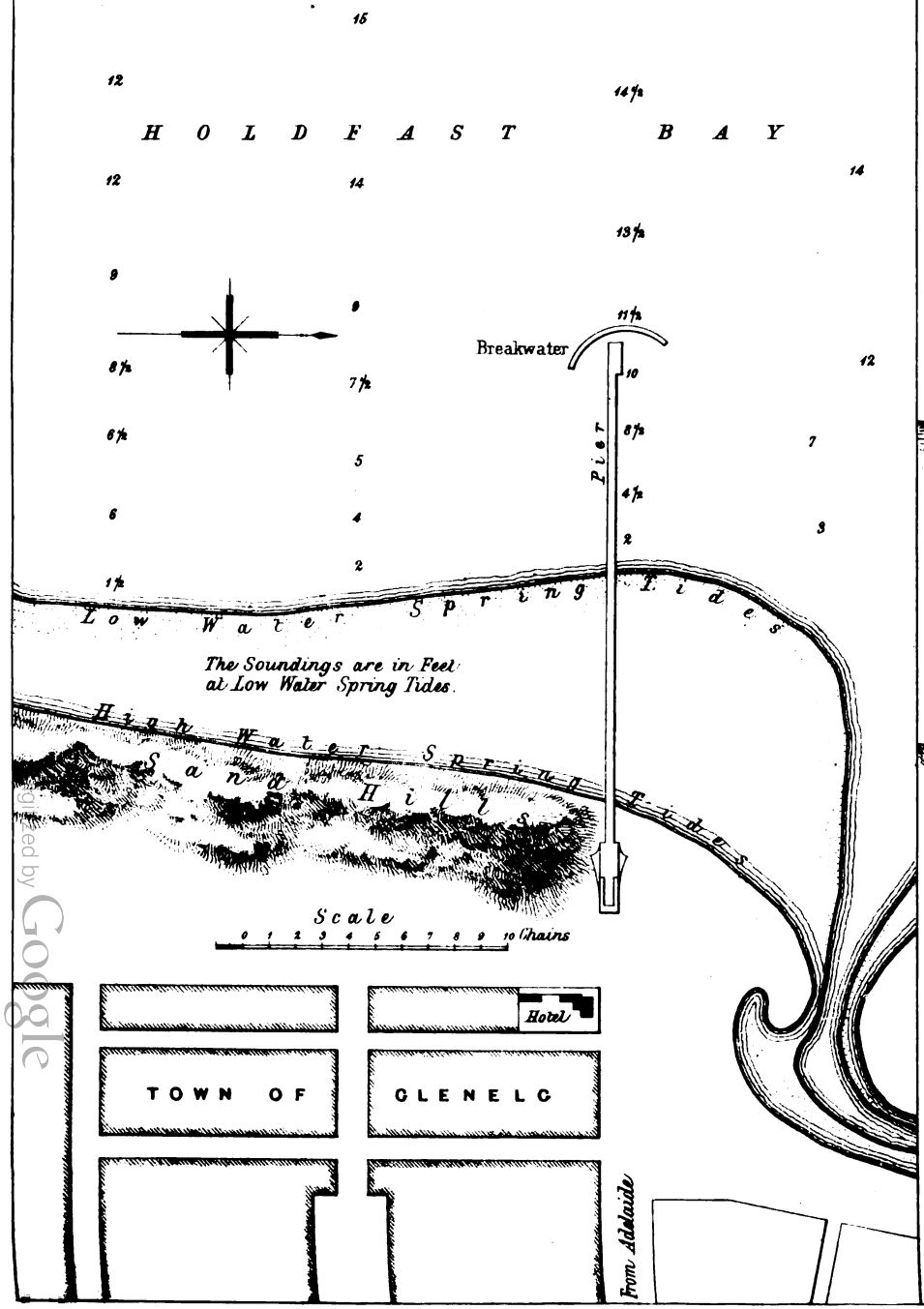
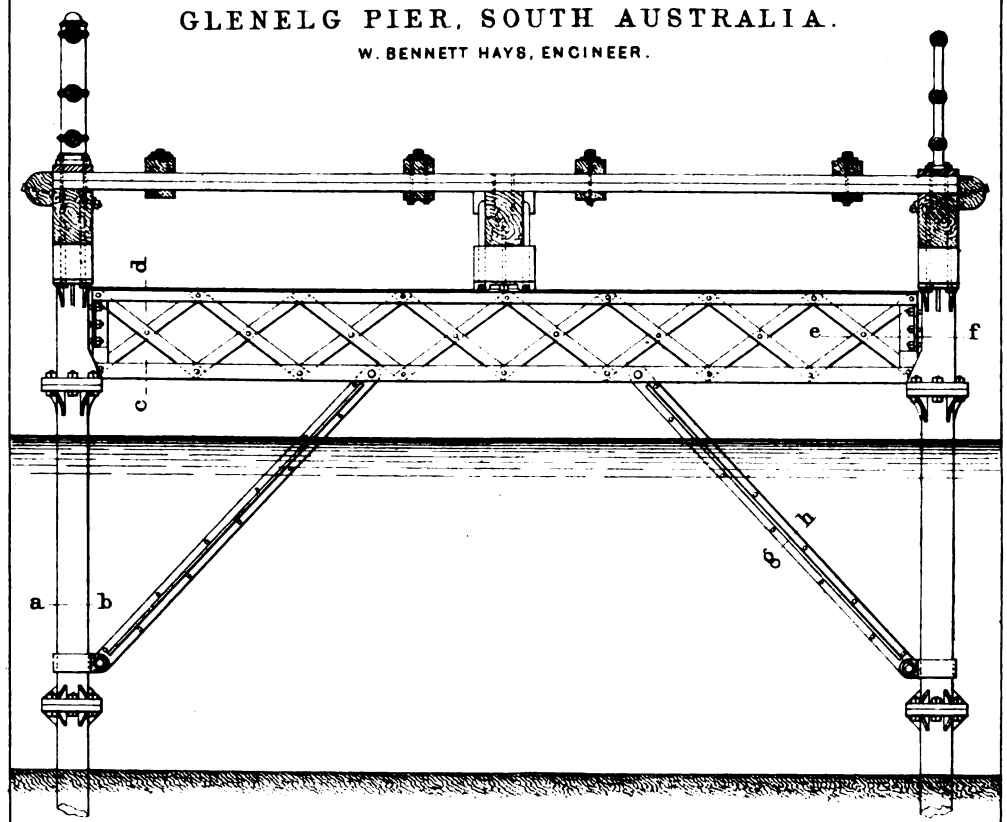
GLENELG PIER, SOUTH AUSTRALIA.

W. BENNETT HAYS, ENGINEER.





Transverse Section.

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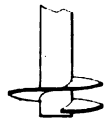
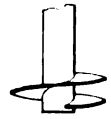
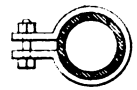
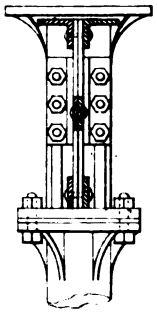


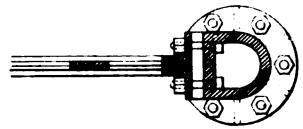




Section a.b.



Section c.d.



Section e.f.

Section g.h.

Enlarged Parts ½ In. to a Foot.

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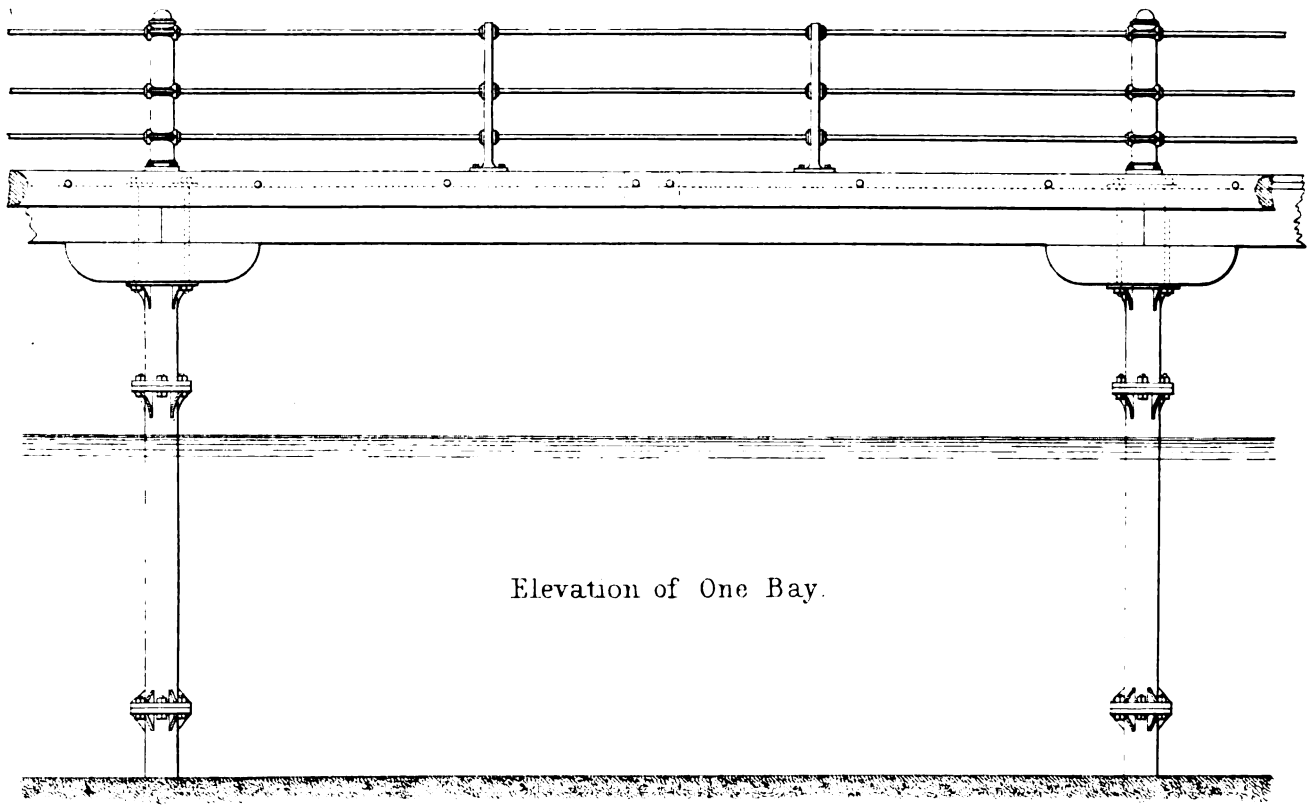
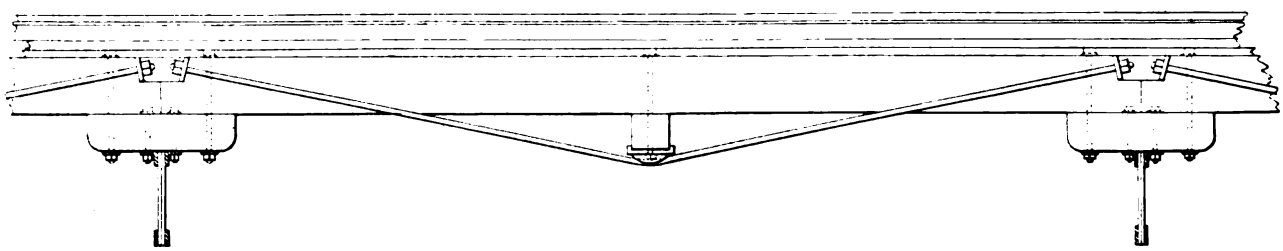
GLENELG PIER, SOUTH AUSTRALIA.

W. BENNETT HAYS, ENGINEER.

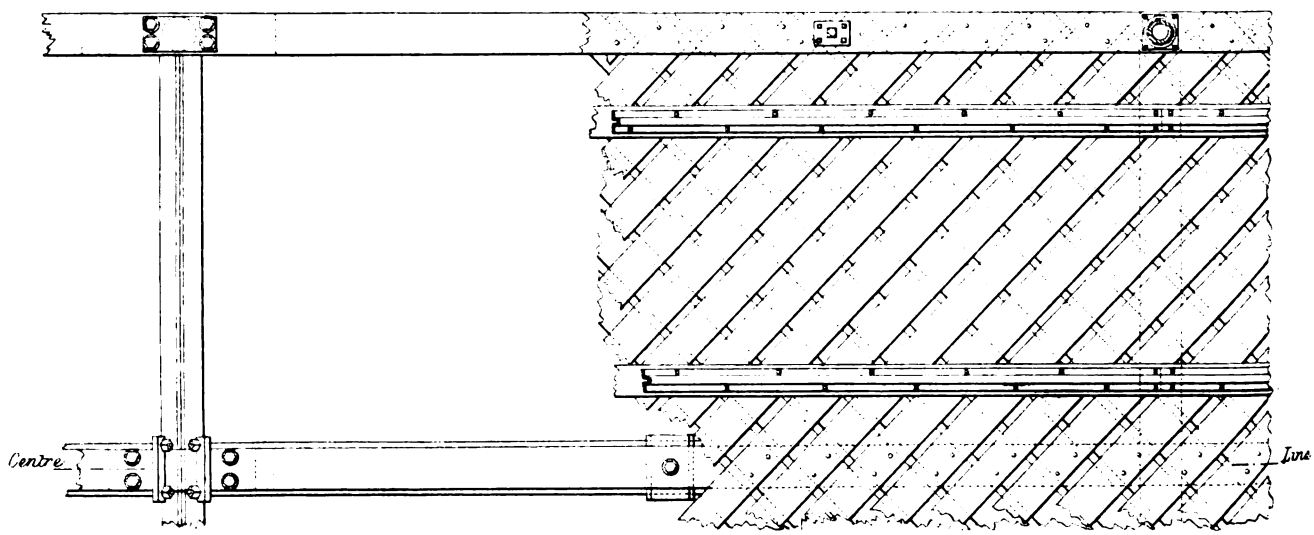


Elevation of One Bay.

Elevation of middle Bearer



Half Plan of One Bay.



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BREAKWATER FOR THE GLENELG PIER, SOUTH AUSTRALIA.

W. BENNETT HAYS, ENGINEER.

Fig. 1

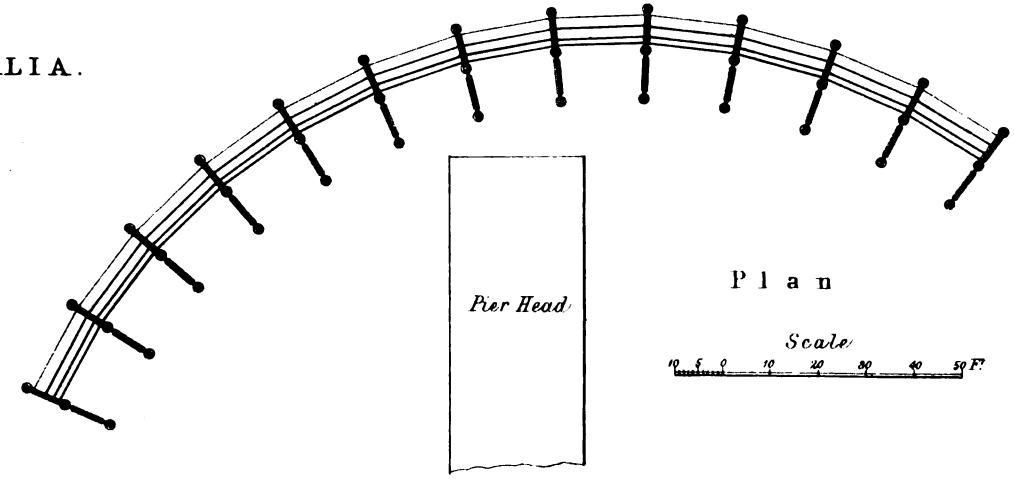
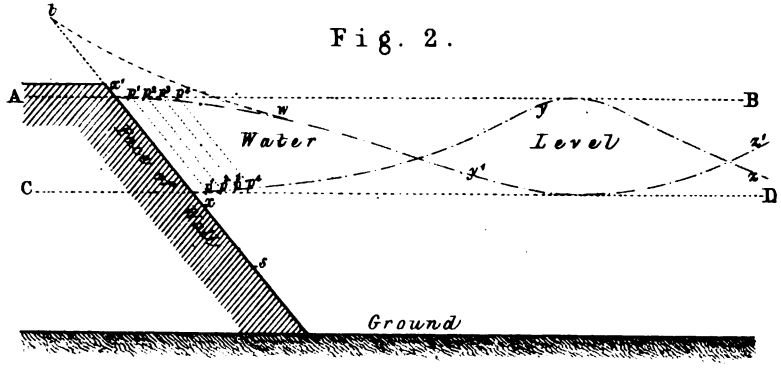


Fig. 2.



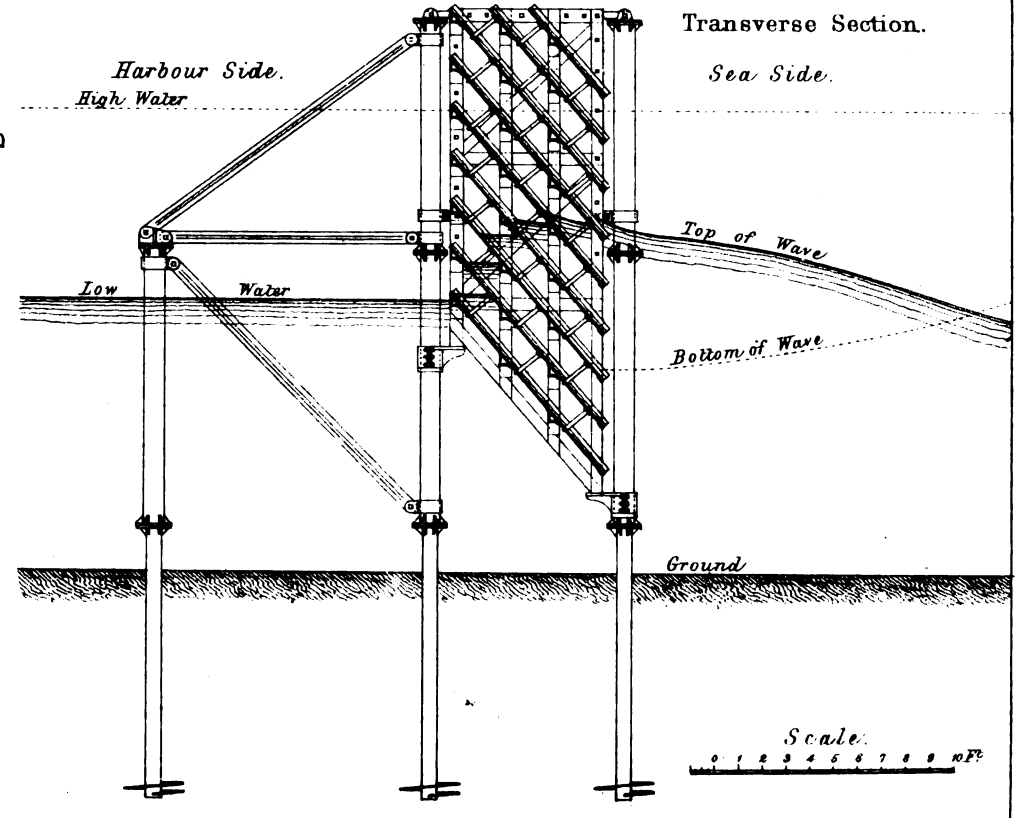
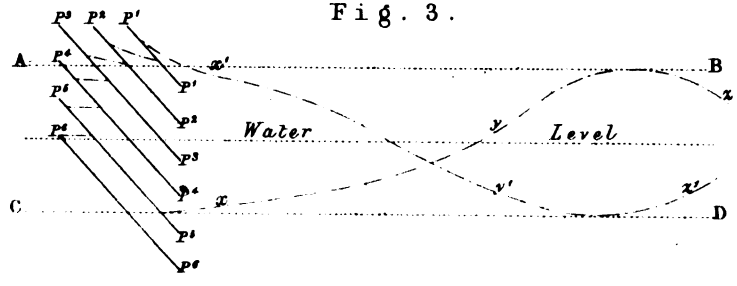


Fig. 3.



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GLENELG PIER AND BREAKWATER, SOUTH AUSTRALIA.

W. Bennett Hays, Engineer.

(With Engravings, Plates V. and VI.)

This pier is about to be erected, for the colonial government of South Australia, at the marine township of Glenelg, in Gulph St. Vincent, situated at a distance of seven miles from the city of Adelaide. It is intended principally for the convenience of small coasting steamers and sailing vessels; also to enable large ships, whose draft of water is too great when deeply-laden to go over the bar-entrance of Port Adelaide, to discharge part of their cargo; and for the more speedy landing of the mails. Its extreme length is 1250 feet, with a depth of 12 feet at low, and 18 feet at high water, at the head where vessels discharge; and has a double line of rails laid down upon it. The platform will be a double planking of native hard wood, laid diagonally, supported on bearers of Memel timber, the whole resting on cast-iron hollow piles, fixed by Mitchell's screw, with wrought-iron cross girders and struts.

The pier being exposed in windy weather to a short chopping sea, which would frequently render it very inconvenient for vessels to lay alongside, will be sheltered at the head by a breakwater, the action of which is more particularly described below. It is constructed in bays of 20 feet, supported on cast-iron screw piles, the platforms being of $\frac{3}{8}$-inch boiler plate, put together with ⊥ irons on the upper side, rivetted on in a transverse direction; and Barlow's rail, inverted, and rivetted longitudinally as bearers on the under side; and further stiffened by pipes and bolts connecting the plates together in the middle of their length. The plates are carried upon frames of bar-iron, $6'' \times \frac{3}{4}''$, rivetted together with cross and diagonal pieces, each plate having a $3\frac{1}{2}$-inch angle-iron on its end by which it is bolted to the frames, and being supported by small cast-iron brackets also bolted to the frames. The frames themselves, when in their places, will be bolted to one another, and will rest upon step castings attached to the piles, and be connected to the piles by wrought-iron clips and links.

The breakwater is arranged in the form of a crescent, presented towards the point of the prevailing winds, and is 240 feet in length. In that shape, and put together as described, it will be of course very stiff. A contract has been taken for the whole of the ironwork by the Uskside Iron Company, Newport, Monmouthshire.

Description of Hays' L'ouvred Breakwater.

(With an Engraving, Plate VII.)

This breakwater consists essentially of a series of any number of planes or platforms, placed above each other at short intervals, and inclined at an angle of about 50° with the level of the water towards the sea or advancing waves. The effect of this arrangement in resisting the sea, so as to form an effectual shelter for landing-places, piers, harbours, or other marine works, will be better understood after a slight examination into the actions which take place in water agitated by waves.

The water itself does not partake of the rapid onward motion which the wave possesses; this motion of the wave is rather apparent than real, being due to the successive rising and falling of adjacent particles of water in a progressive manner; the actual motion of the particles is very nearly in a perpendicular line, being slightly inclined in the direction in which the wave is travelling, somewhat in the manner indicated by the dotted lines in fig. 1, where the arrows show the direction of the motion. But this motion obtains only where there is considerable depth. As soon as a wave reaches water which is shallow, and where the bottom is inclined from the horizontal, as is generally the case near coasts, the reaction of the ground produces a modification in the motion among the particles whereby the wave is driven on, by its upper portions acquiring a more rapid forward movement than the lower. If the water continue to increase in shallowness, this difference between the rates of progression of the lower and upper portions becomes greater and greater, until at length the upper particles fall completely over the lower; and the onward progress of the whole, which had been gradually increasing in intensity, now reaches its climax, and ends in that mighty rush of broken waters witnessed in the phenomenon of the surf on a sea beach.

Waves breaking thus on a beach manifest an extraordinary amount of destructive force. The movement of the water, which was before undulatory in nearly perpendicular lines within the limits only of the rise and fall of the wave, becomes now almost wholly horizontal; and, being continuous in one direction, acquires a constantly increasing momentum, which acts with proportionate violence upon any obstacle that it may meet with. The rapid destruction of a stranded ship affords sufficient proof of the magnitude of this ever-recurring force. All artificial sea defences that partake of the long sloping form of a natural beach, are liable to the same destructive action.

When a wave in deep water meets with the resistance of a perpendicular face, as a wall or cliff, the amount of force developed is not nearly so great as that upon a sloping beach, or artificial breakwater of like form. The gradual conversion of perpendicular into horizontal motion does not here take place, as upon the beach. But that small portion of horizontal motion which the wave possesses, combined with the vertical, as illustrated in the diagram fig. 1, is now suddenly arrested, and the amount of shock thus sustained by the opposing barrier is that due to the momentum possessed by this horizontal motion. A further force is also doubtless developed, similar to that of the breaking wave upon the beach, by the portions of the wave that come last upon the wall, overtopping those which had first reached and been impeded by it, and thus, to a certain extent, breaking against it.

A wall, whose face should have a slope as nearly as possible parallel to the general line of movement possessed by the particles of water in a wave, as fig. 2, would doubtless be least exposed to a shock. Let us examine more particularly the actions that would here take place. Let the line A B represent the greatest height to which the wave rises above the general level of the water; C D the lowest level of the wave. Conceive, first, the wave as it begins to approach the wall, as shown by the strong line $x\ y\ z$. Then trace it in its onward progress, consisting, it must be remembered, not of a forward movement of the whole mass of water, but of a successive rising of the particles near x, and a corresponding depression of those about y, until it has attained the position $x'\ y'\ z'$. Now, it is evident that the particles at x, as they begin to rise against the face of the wall, will meet with a certain amount of resistance from friction against it, having their velocity diminished thereby; the particles near y, not meeting with the same resistance, will then begin to fall over those at x with a corresponding increase of velocity. Let the wave be now divided into a number of segments or slices by a series of imaginary parallel planes, $p^1\ p^2, p^3, p^4$, &c., the particles of water at p^2 will, as the wave advances, fall over those at p^1, those at p^3 over those at p^2, p^1 over p^3, and so on, until the whole momentum of the wave has expended itself upon the face of the wall; and the effect of the accumulated forces of the whole mass will be to drive the water up the wall considerably above the original level of the top of the wave, as shown by the strong dotted line $w\ t$. Thus, in order to check effectually the progress of this wave, the face of the wall would have to be continued as high as the point t. It is further evident, that, for all practical purposes, the wall is not at all required lower down than the point to which the undulatory effect of the wave extends, which, near coasts, where alone harbours and sea defences are constructed, seldom exceeds 10 or 12 feet below the surface.

Let this point be s, then that portion of the face of the wall included between s and t is all that is really required to form an effectual breakwater. But it must possess sufficient stability to resist, not only the gravity of the water due to the height of the wave, but also the further force of impact consequent upon the complex motions of the water upon it, which have been described.

Let now the imaginary planes, p^1, p^2, p^3, &c., be converted into real ones, P^1, P^2, P^3, &c., arranged as in fig. 3, the lowest point of P^6 being placed beneath the influence of the wave's undulation, the lines A B, and C D, representing, as before, the limits of the rise and fall of the wave, and $x\ y\ z$, $x'\ y'\ z'$, the two positions of the wave itself; and examine the effect.

The segments or slices of water, which were before represented as falling over upon one another, and eventually expending their combined and accumulated force upon the face of the wall, which may be here represented by P^6, are now prevented from so doing, being retained by the several planes, P^1, P^2, &c, each of which may be regarded as another interposed wall, sustaining only the limited portion of water which rests between it and the plane next above it. Thus this structure of combined planes is,

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it will be seen, almost entirely relieved of the shock or force of impact which the wall alone had to sustain, little else remaining than the gravity due to the height of the column of water upon it. The wave, as it flows up the planes, will rise upon the first two or three of them, P^1, P^2, P^3, only to a very small extent above its original level; those lower down will have this remarkable effect on the motion of the water. Regarding the spaces between these planes as enclosing so many separate columns, whose bases are at the lower ends of the respective planes, it will be seen that, in proportion as these bases are further down beneath the water-level, so they are further removed from the undulatory influence of the wave, until, at last, that between P^5 and P^6 is altogether beyond the reach of this influence. Consequently, the height to which these columns of water will rise between the planes suffers a successive diminution, until the last column between P^5 and P^6 remains quite undisturbed.

The maximum height of the several divisions of the wave will then be somewhat as shown by the strong shaded lines in the figure. As soon as the momentum of the wave has thus quietly expended itself upon the planes, the water of course retires from them, and by its reflux, tends to drive back the wave in a direction opposite to that it had before, and thus effectually prevents its further propagation on its original course. And this result is not theoretical only, but has been verified by numerous experiments. Thus a clear idea will, it is believed, be formed of the manner in which this arrangement of parallel inclined planes forms an effectual breakwater, and one which is exposed to the least possible amount of destructive action from the force of the sea.

It should, however, be borne in mind, that this breakwater is adapted only to situations where there is some depth of water;—it is not calculated to resist the shock of breaking waves near a beach or in very shallow water. In practice, these planes may be formed either of wood or iron. The positions in which they may be advantageously used, and the particular modes of constructing and supporting them, are, of course, subject to the greatest variety;—a few examples are given. That shown in the Plate is the form used for sheltering the Glenelg Pier, the construction of which has been already briefly described. This is adapted to situations where there is no great depth of water and the rise of tide is small, and where the ground is suitable for fixing piles. The plates are here extended in height so as to include the whole range of tide from high to low water.

The breakwater may also be adapted for temporary purposes, such as protecting marine works that may be in progress from the violence of the sea, and thus freeing them from that which is often a great hindrance, and a source of much difficulty and delay. It may be constructed of timber, the plates being formed of planks securely framed together, and supported upon a kind of raft composed of balks or booms framed and braced together; and may be made in any suitable lengths, which may afterwards be connected together. It is not intended to be fixed to the sea-bottom, but to *float* on the surface, where it may be held by moorings, or be steadied in its place by a row of piles, against which it may rest. It has been found by experiments on a moderate scale, that a breakwater of this form is not subject to disturbance from the sea, that is, *it does not rise and fall with the waves*. This, on a little consideration, will appear obvious, because the raft of timbers, on which its flotation mainly depends, is placed behind the inclined planes which arrest the waves, and is, consequently, in still water; and the wave, when it rises and would, under ordinary circumstances, *lift* a floating body, acts then by its gravity upon the planes, tending rather to *depress* them, and thus exerting a counteracting force. The existence of another counteracting force was also proved by the experiments. When a wave was in the act of advancing upon this floating breakwater, instead of the structure being driven, as might have been expected, in the direction in which the wave was travelling, it was seen to be rather *drawn in the contrary direction*, or *towards* the wave; showing how completely the arrangement of numerous parallel plates neutralises the force of *impact*. During the reflux of the wave from the plates, the structure was forced *backward*, that is, in the direction of the travelling wave. This action is evidently due to the momentum of falling water upon an inclined surface, and its force is easy of calculation.

For permanent structures, in situations where there is a great depth of water, and where the rise of tide is considerable, the consequent great length and number of the piles, and the extent of the plates to include both high and low water, would involve considerable expense. For such situations an arrangement is now proposed. This is a floating breakwater of wrought-iron. The plates themselves are floated by a hollow wrought-iron vessel fixed partly under them, but having a sufficient area exposed above water to give the requisite buoyancy, so arranged as to be as nearly as possible in equilibrio. As, however, the equilibrium of such a vessel, with the plates upon it, is *unstable*, a hollow cylinder at the back is added, and the two vessels firmly connected together by wrought-iron bracing; thus giving the utmost stability to the whole. These may be built in any convenient lengths, floated into their places, and afterwards connected together end to end so as to form a continuous breakwater of any desired extent.

Instead of holding this breakwater by moorings, which are subject to constant wear, and liable thereby to break adrift or to drag, it is proposed that piers should be built at suitable distances apart, either of masonry, piles, or in any manner that the nature of the situation may render expedient; against these the floating breakwater may rest, being placed on the *sea*-side of them, and steadied by vertical guides, which leave it free to rise and fall with the tide. Attention should be paid to the construction of these guides, so as to involve as little wear as possible from the friction of this necessarily moveable part of the structure.

One of the advantages which a floating breakwater of this kind possesses over a fixed one is, that the former may at any time, in fine weather, be easily detached (a spare one being had to put in its place) one portion at a time, to be *docked* for examination, repairs, or painting. Slight leaks may be examined and stopped by entering the floating vessels from a man-hole; and pumps may be inserted in them to keep down ordinary leakage.

The principal advantage possessed by this breakwater is, that it deals with the opposing element where alone it is wanted, namely, on the surface. At a certain depth, all is tranquil; and whatever part of the structure of a breakwater extends beyond that depth, is not only unnecessary, but is, in most cases, positively injurious, by so interrupting and modifying the tidal currents as to produce accumulations of mud, sand, or gravel, and so reduce the depth of water where it is most wanted. This reduction of the structure to its narrowest limits effects a corresponding reduction in cost, and affords the utmost facility of construction.

It may be objected, that the materials of which alone this breakwater can be made are perishable as compared with stone. This is true to a certain extent: but the question of saving in first cost and time is one of no little importance; and the reduction of these will, in most cases, be such as to make the interest of money more than pay for maintainence and renewal. Besides which, when it is considered what vast sums are now embarked in marine structures of all kinds in which iron is used—ships, lighthouses, piers, and such like—it will appear that the practice of the present day is anything but unfavourable to the use of this material in works of such a nature.

THE ARCHITECTURE OF THE FUTURE.

By Samuel Huggins.

[*Abstract of Paper read before the Liverpool Architectural Society*].

A notion prevailed that a new style was the thing we wanted; our chance of a new style was dependent on the amount and importance of the new elements we had to contribute. We knew how styles had arisen aforetime; each had both a father and a mother, and owed its birth to the influence of some new principle, or the abandonment of some old one, upon the style of the day. One thing was certain, we could so use the present styles as to produce true and original works. To deny this was as absurd as to deny to the poet the power of producing a new poem without first inventing a new language. The historic association of the Gothic or classic architecture with the spirit and character of the period of its production was an objection that should be confined to individual works. The styles might be productive of edifices that should bear the broad seal of any time, as much of the present as of the past day, and be unequivocal exponents of the mind and circumstances of the age. But individual truthfulness like this would inevitably tend to the desired expansion and ramification of the style. Something every now

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and then would appear that had not been seen before; if it were ungenial to the style its spirit would reject it; but if otherwise, and the work in which it appeared was found to be in accordance with the unerring laws of art, and all its parts were in unison, the innovating feature would soon be absorbed into the system, and form a part of it. Thus was the system made, and thus was it to be carried on. This was the way the classic architecture was formerly treated in one of the greatest art revolutions, viz., that which took place soon after the time of Constantine the Great in the development of Byzantine art, where originality was observable in every form in the capitals, in the mouldings, &c. They introduced new principles of decoration, such as sinking carved work of capitals beneath bounding lines of form, instead of projecting it beyond them. It was not at all important that we should leave a uniform architecture, *i.e.*, an architecture all in one style, to the inspection of posterity. The object we had to set before us was to erect works such as would individually comply with the conditions of original and genuine works of art. Any mixture of style consequent upon our working in a plurality of styles was not to be feared so long as it was done by men who understood their work. No matter whence the origin of elements in the hands of the true artist; his work would be *one*, and rightly affect the mind. It did not follow that because the Greeks and other ancients had but one style for temple and theatre and other edifices that a plurality must therefore be improper amongst us. Those who urged this, forgot the difference between our civilisation and that of ancient times. In Greece all was unity; everything was the emanation of a master feeling or passion, which was invariably a devotional one. It was of no use to say that this ought to be the case with us, because the architect had to do with society, not as it ought to be, but as he found it. The present state of modern life might, perhaps, be best represented by a plurality of styles; what we had to do was to work truly in them. There would be unity and harmony in architecture if we did so; and though starting from so many different points, and traversing so many different roads, we might meet at last in one beautiful and pleasant one. A general unity in our architecture was to be secured not by our working from the same style, but by our working from the same principles, viz., the great polar principles of art, which were founded on those of nature herself. And whether we worked in one style or in twenty styles, there was no safety from confusion and discord but in constantly going back through all styles to their great fundamental principles, and appealing to the original elements in their constitution. It was looking to the ever-shifting clouds of fancy and fashion of the day, and in appropriating what was but temporary and local in the past, that had caused the divided action amongst architects so much complained of, and which no combination of the profession or interference of Government could remedy. Principle was not only unity of action, it was wisdom, strength, and beauty; and it would not only give unity to architecture, it would unite all the arts of decoration *to* architecture, if it were suffered to regulate them; it would unite the architect, the upholsterer, the weaver, the potter, as in all great art periods they were united, as shown by existing remains. There was not much need of quarrel as to which style was best to be used for any given purpose or purposes. Some features and forms were thought peculiar to certain styles, and deemed admissible into no other; but there was, perhaps, few forms in any style that could not be translated into another. It was not style, but the intellectual and imaginative power that was to apply it, on which success depended. The dispute about styles seemed not much unlike a speculation upon the merits of different military uniforms or kinds of armour; and, indeed, to calculate upon the result of architectural doings from the character of the style or styles we adopted, was as idle as to predict the issue of an encounter of warriors from the mere length of their swords or strength of their armour, without taking into account the personal force and prowess of the combatants. Notwithstanding what had been advanced, it was nevertheless true that one style was better fitted for general purposes than another, as there was much difference between them in point of scope if not of power. He considered the Greco-Romano system was the soil most capable of yielding the multiplicity of forms which the exigencies of the future would demand from architecture. The classic style—having been carried to perfection in but one very limited and simple class of structures, the Greek temple—afforded us more room for new and original combinations than its rival, the chief productions of which, the cathedral of the middle ages, the attempt to emulate would be hopeless. The general and dominant style of the future, he believed, would be mainly composed of the Roman arch springing immediately from the Greek or Roman column, *i.e.*, the noble Byzantine and Lombardic styles, known under the general appellation of Romanesque, divested of everything like barbarism, and restored to classic purity. This did not involve the abandonment of the entablature, for with such purified ordinance could be well combined the classic colonnade or portico in its original integrity. The style so generated would be the true artistic blending of Greek architecture with Roman arcuation. It was when the column was placed under the arch as an arch-pier that the marriage of the two styles was truly consummated, and artistic unity secured. By the system he had endeavoured to sketch out would be embraced every necessary feature required by our climate and state of social existence, such as sloping roof, window, portico, porch, and so forth, and this should be well observed. A true Anglo-classic building was one from the visible composition of which no needful feature was excluded, and in which the features we borrowed from classic antiquity or derived from any foreign source, such as the portico, were fully adapted to our purpose, and cast into the new moulds that by the circumstances of time and place were prepared for it. A building, however artistic in its composition or pure in its details, was defective in character if visually wanting the roof, which in England must play its part in the architectural drama whatever the style; and the same might be said of the window, which for various reasons had taken such a hold of the mind and heart of the people of this country, that, except in some peculiar instances, we should never be allowed by public feeling and opinion to omit. The portico was also an important feature in our future architecture; but it must assume a very different character to what it had generally assumed in England. It must be adapted to the climate, than which there was nothing more important to bear in mind. Nothing contributed so much to a national and distinctive character in our buildings and streets as a due recognition of the climate of the country. It was often suggested as a means of embellishment of public squares to erect fountains. The scheme had often been tried, but had succeeded nowhere in this country as in Italy and France; and the reason was obvious—there was no natural call for the play of fountains in a climate where the elements were so often and so bounteously playing themselves. He thought himself that a large chafing dish, containing a good fire, would be a far more agreeable and appropriate ornament in the centre of an English place or square, for at least eight months in the year, than any fountain. He referred to St. George's Hall as an edifice well suited to the illustration of his remarks, and passed a high eulogy upon its exterior, which, whether classic or English, was in a high degree artistic and beautiful. Here eulogy, however, though qualified must cease. Passing to the accessories, we came upon a portion (the enclosures) on which the critic, were charity herself to assume the office, must pass an unmitigated sentence of condemnation; a portion which, viewed in the mass, no one could accuse of being too Greek or too Roman, for it was not in the spirit of any period in time's cycle, or of any country under the sun, unless, indeed, more archaic than any, its discordant types might have existed in those parts of the far-famed building the Tower of Babel, which were executed subsequently to the confusion of tongues. The approaches to the building were a subject not merely for regret to architects, they must be an offence to every one possessed of the smallest share of taste. After condemning the two tall columns in Lime-street, he remarked they were worthy ingredients of the enclosure of which they formed a part, and which consisted of disjointed fragments from all the architectural fashions of the globe, placed in every variety of position—making every possible angle to each other and to the horizon, and mixed up without regard either to mechanical connection or artistic unity—Cyclopean ramparts, Egyptian moles, Italian balustrades, Elizabethan palisading, lamp-posts from Greece, gate-piers from nowhere; and forming a whole, if a whole it could be called, unlike anything in earth or sea, and in which the only artistic quality—a very low and here a totally inapplicable one—which it was possible by such elements to embody, the picturesque, it had failed to secure.

There are a variety of other topics which, in the course of a long paper, were examined by Mr. Huggins. He advocated a variety of principles which he considered had yet to be brought in, or were not sufficiently recognised in the art; and adverted to others which had to be discarded—among the rest to symbolism,

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which had been a very nightmare on the genius of the architect, clashing with convenience, symmetry, and every great principle of design, until the primal source and end of all art had been forgotten. In conclusion, he contended that the style of the future, combining, as it would, greater elements than any former style, and based on everything great and glorious in the foregone, might pass beyond the range of the Greek or the Gothic, allow the fullest scope for man's intellectual energies, and be receptive of all possible elements of change for any period of time.

EDUCATION IN ARCHITECTURAL ART.

SIR—Our recent free intercourse with France, by which we have been enabled to estimate the great superiority of some of its artists over our own, in certain departments of art, calls upon us to make some remarks on the defective system of education that is pursued in England, more particularly in reference to architecture and the decorative arts. In alluding to this subject, we may observe that is in vain for men (however learned they may be) to write disquisitions and to lecture on particular sections of the fine arts, if their labours do not tend in some degree to improve the rising generation. In vain is it to expatiate on the gloomy grandeur of the works of the Egyptians, the pure style of the Greeks, the luxurious splendour of the Romans, and on the more recent productions of the moderns, if the educator does not elucidate his subject in a *practical and familiar* manner, and also point out to the student the exact precedents that may safely be followed, and those which should be rejected, in the acquirement of his taste; so that, eventually, he may be enabled to produce works containing in themselves those characteristics of correct proportion and magnificence, and also those requisites of convenience and appropriateness, that may suit the wants and requirements of our own particular age and country.

However much we may differ from certain opinions expressed by some of your contemporaries, we must also assert that it is equally vain for any body of men to profess, or expect to *manufacture* really great architects and designers by any fixed conventional system of educational training. In proof of which, it may be stated, that it would be difficult indeed to name any *really great* architect which the Royal Academy of London has produced since its formation. No!—it is perfectly erroneous to suppose that any man of energy, perseverance, and true genius, would be so consummately foolish as to spend so much valuable time in such unsatisfactory probational studies as those required by the Royal Academy; the greater portion of which is utterly useless to him in the future practice of his profession. Besides, such is the fluctuation of taste in all matters architectural, that after the student has been lectured into a superficial, theoretical knowledge of the Greek and Roman orders, and their abstract principles, it is highly probable that during his whole professional career, he may not be called upon, even once, to exercise his skill upon a single building in either of the above styles. It is presumed, therefore, that the lecturing professor, instead of dwelling so exclusively upon what the late Augustus Welby Pugin styled "Pagan architecture," ought to pay greater attention to that architecture which is more fitted to a Christian community, and lay down rules and principles by which results ought to be effected, equal, if not superior, to those which were employed in the construction of some of the cathedrals of the middle ages, and the most celebrated edifices of the revivalists.

The object of the present remarks is to show that the system at present pursued in England, to teach architects and designers their professions, is based upon false and erroneous principles. It certainly may teach them, by a sort of formal routine, an amount of theoretical general knowledge that is very rarely brought to bear upon the absolute requirements of the present age, which is one of progress; but, assuredly, it will *never* tend to make such men as Inigo Jones, Wren, or Vanbrugh, who never studied in any architectural school, but produced the great works which bear their names by the indomitable power and vigour of their own genius, and not by any conventional system of monotonous and useless probation We do not mean to contend that a man of genius requires no aid—far from it; but to affirm that the aid he requires is of a negative character. If our government, instead of throwing away enormous sums yearly in the payment of incompetent persons, would vote a handsome sum for the formation of a truly useful, national, architectural museum, and appoint two or three *really competent men* to direct the attention of the students to those examples only which contain within themselves the attributes of real beauty and utility,—we then might have some hope of seeing buildings arise in our land that would do honour to the nation, instead of the soulless and abortive copyisms that have been conceived and erected in our country for the last century, which have tended so much to degrade us, in the eyes of all enlightened foreigners, in matters of architectural and decorative art. However, we trust that the self-complacency which has beset and deceived us so long, is now banished by the sense of our inferiority, and that some fresh blood, of the right sort, may be infused into our morbid system, and that we may be aroused from our apathetic mediocrity, and eventually be enabled, by more strenuous and vigorous application (directed in the right manner), to equal and also to surpass some of the best men of the olden time.

JUNIS.

ST. PAUL'S EPISCOPAL CHURCH, DUNDEE.

WE are happy in being enabled to enrich our pages with a perspective view of this beautiful edifice, which has just been completed and opened for divine service. It is many respects the most interesting structure which Scotland in modern times has produced, and deserves notice as a successful treatment of a large town church—neither cathedral nor collegiate—but exactly suited to the wants it is intended to supply. The architect is Mr. G. G. Scott, of London, who has imbued his design with true local characteristics. Externally, one cannot fail to observe the commanding position it occupies, being on the site of the old castle of Dundee. The castle-hill rises abruptly from the north and west, so that the foundation of the church approaches the tops of the neighbouring houses, while the great height of the steeple itself (210 feet), thrown up on such an elevation, renders it conspicuous in every distant prospect of the town. Additional importance is given to this feature, which stands at the west end, by the noble approach to its principal entrance by three or four flights of steps—from twenty to thirty in all. Imitated in some particulars from the venerable old steeple of the town church, it is more elegant in its adaptation, while it has the addition of a spire, which, if the old steeple ever had, has long since been destroyed. A principal feature in the tower is its external gallery, corbelled out at the level of the belfry stage, and another above at the base of the spire. These parapets are perforated by quatrefoils in circles. A staircase turret (octagonal) is attached at the north-west angle, which continues to the full height, and is terminated by a pinnacle. The belfry windows, it will be noticed, are characteristic; and, though quite simple, exceedingly well managed. The western doorway, before alluded to, has deeply recessed jambs, and additional effect is gained by slightly thickening the wall externally, and gabling this extra projection. Within, the tower is groined. On entering the building, its plan is at once seen to be cruciform, having a nave, two side aisles, north and south transepts, chancel and chancel aisles; the chancel being terminated by an octagonal apse, whose windows are of two trefoil lights, with quatrefoil in head. The general effect of the interior is that of elegant loftiness, to which the proportions of the aisle windows (which, it will be noticed, are all gabled externally) not a little contributes. The piers throughout are circular, having octagonal capitals and bases. The roof, both of nave and aisles, is stencilled in chocolate and white, and that of the two chancel aisles varies this by repeating the same patterns in blue and gold.

Looking westward from the interior, the eye is arrested by a bold tower arch. It is of three orders, and at about half-way up its height is traversed by a projecting pierced screen, serving for a front to a small gallery, and not excluding the view of the west window. Attached to the tower, on the south side, is a large vestry, lighted by a well-contrived skylight in wood, mullioned. The vestry for the clergy is in the south-east chancel aisle; it is entered also by a passage from the bishop's house, on the north side of the church. Many of the windows are filled in with stained glass—some memorial; the five in the apsidal termination of the chancel being filled with stained glass by Mr. Hardman, of Birmingham. Others have been furnished by Mr. Scott, of Carlisle, and Messrs. Gibbs, of London.

The pulpit—a gift—is of Caen stone, having Peterhead granite columns at the angles, and generally of octagonal form. In each of the panels of the sides is sculptured a head of one of the

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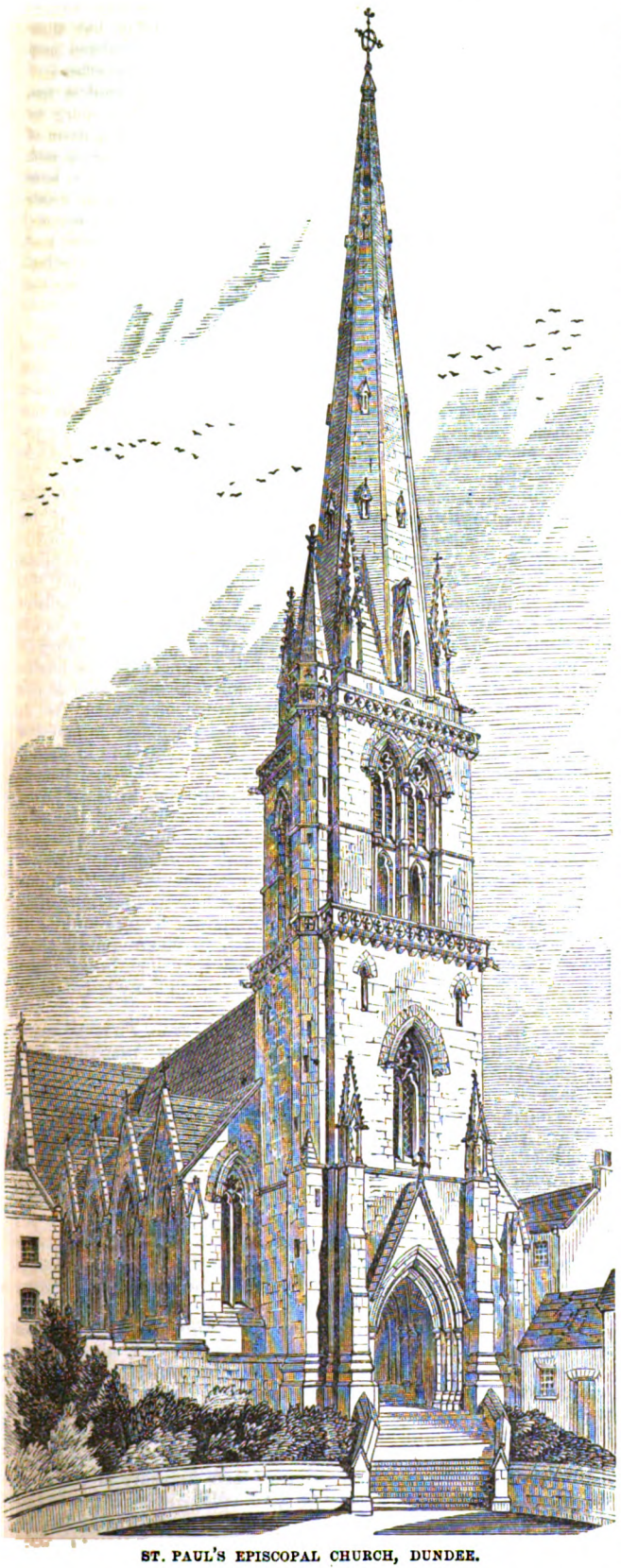

ST. PAUL'S EPISCOPAL CHURCH, DUNDEE.

Evangelists. The brass lectern was supplied by Mr. Hardman, and is a present from the Dowager Duchess of Argyll.

The principal dimensions of the edifice are as follows:—the length of nave, 84 ft. 4 in. by 24 feet wide; the width of each side aisle, 10 ft. 6 in.; and the total width of the church at the transepts, 64 feet. The length of the chancel, including the apse, is 35 feet, and its width 24 feet; the height of the walls to the nave roof, 42 feet, and the height from the floor to the apex of the nave roof is 67 feet; the height from chancel floor to the groining (stone) is 45 feet. The tower is, externally, 27 feet square at the base.

There are no side galleries. The seats, of deal stained and varnished, are open, and will accommodate about 600 persons. The church is built, rubble-fashion, of the grey sandstone of the district; the whole of the external dressings, including the spire, being of sandstone from Bannockburn; and the internal dressing, as pillars, arches, groining, &c., being of white sandstone from Fifeshire. The cost, exclusive of the site, is calculated at about 11,000*l*.

We have been minute in describing thus particularly the several features of this structure, since it deserves the character of a model church, and has been carried out with a degree of care highly creditable to all concerned. The excellent Bishop of Brechin has been an active promoter of the work; and, with the Bishop of Moray and Ross, and numerous other clergy, took part in the services on the occasion of the opening.

CULTIVATION BY STEAM; ITS PAST HISTORY AND PROBABLE PROSPECTS.

By John Fowler, Jun.

[*Paper read before the Society of Arts, London.*]

The importance of this subject is now almost universally acknowledged; it is a question affecting an expenditure of at least fifty millions sterling annually—the cost of horse labour in agriculture; and its progress is anxiously watched by men who, even three years ago, would have been sceptical of its ever attaining any practical value. Not long since it was the common remark, among both engineers and agriculturists, that though steam cultivation was probably practicable, yet the cost of ploughing by horse-power was not sufficient to render it remunerative or likely to be generally adopted. But the experience of the last few years, and the advantages that have accrued from the more rapid and perfect execution of barn work by steam-power, have tended to lead the agriculturists to set a different value upon it; and I believe that body are now quite prepared to give a warm welcome to any means that will give them greater power over the material with which they have to deal, and that will enable them to cultivate the soil more expeditiously and thoroughly, even should there be but little economy over the present plans. In an uncertain climate like our own, time is more essentially money in dealing with the soils than in almost any other operation we can name; and, if that axiom is found universally to hold good in its application to every other sphere of human industry, it must be doubly applicable to the cultivation of the soil, where the loss of a week is often a serious injury to a crop. Of course, economy would be a great desideratum, and I hope to be able to show that cultivation by steam-power may be performed at a little over half the cost of horse labour; but I do not think that this is absolutely essential to its extended adoption.

The change in public opinion to which I have alluded, and which I think I may safely reckon upon, will render it unnecessary for me to endeavour to show its importance, or to do more than allude to one or two matters that may give a more pointed direction to our inquiries.

The work of a farm may be divided into two classes—field operations, and the cartage of corn, manure, &c. Steam, in its present state, may be easily applied to the former of these, but its application to the latter is still surrounded more, I believe, with the mist of inexperience than with mechanical difficulty. The horses required upon a farm may be materially reduced by the assistance of steam in field operations, and those operations may be, as before stated, more rapidly and thoroughly performed; yet, until steam is also available for carting, it can only be regarded as an important auxiliary; and, though the half loaf may be better than no bread, yet the possession of the first half only renders the other half still more valuable and necessary.

Thus we have to seek the solution of two mechanical problems—first, the application of steam to field operations; second, to the carting and harvest operations of a farm. The harvest operations may, possibly, be brought under the head of field operations, and

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executed by the same machinery; if so, we shall, unquestionably, have gained the largest half of our loaf.

Having thus referred to the points that seem most to require our present attention, I will now ask you to follow me through the past history of our subject, a history that bears an exact resemblance to that of all the great mechanical realities of our age,—the steam-boat, the railway, and even the steam-engine itself; except in the fact that the greater talents, means, and energies that have been devoted to those subjects, have succeeded in more rapidly developing them into great facts. Time will not allow me to trace the resemblance as accurately as I should like. I think it would encourage us to look forward with perfect confidence to a similar reward to our labours in this direction, and one not less important than the best of them, but I must content myself with remarking that its birth was coeval with theirs; like them, two hundred years ago, it commenced in the minds of those who are more poets than mechanics, who overleap all practical difficulties, and to whom thoughts are realities.

Every new mind gave greater tangibility to the crudeness of the first conception, until, in our own time, every possible idea seems again and again to have been remodelled and served up with some new lights, but, unlike them, no master spirit has as yet taken this undigested mass and given tangible shape and practical value to their *ideas*. [Mr. Fowler here gave an abstract of all the patents that have yet been taken out bearing on the question of steam cultivation, with a short notice of their peculiarities, for which, he said, he was indebted to Mr. Burness, of the *Mark-lane Express*, and to which he referred them for detailed information.] There are fifty-five patents there enumerated, which may be all classed under the following heads:—

1st. Locomotive engines used for drawing agricultural implements. Motion given by driving the wheels, by winding along a chain or rope, by rack railway, and by thrusting on crutches.

2nd. Locomotive engines working rotatory cultivators.

3rd. Rotatory cultivators to be driven by steam, mode of working not specified.

4th. Portable engines, used to wind up ropes.

5th. Portable engines, driving endless ropes, working windlasses.

6th. Portable engines, driving endless ropes, working rotatory cultivators.

As early as 1630, David Ramsey took out a patent for making the earth more fertile, &c. Mr. Ramsey seems to have had an idea that the fire-engine then known could be employed for cultivating the earth; there is no specification of this patent, and he, in common with many of his successors, imagined that any new power must be applicable to agriculture as to other purposes.

The next patent was by Mr. F. Moore, in 1767, nearly 140 years later. This patentee's idea assumed a more definite shape on the subject, and as far as can judged from the specification, he imagined that steam-power could be applied to agriculture by a carriage travelling over the land, driven by steam, and used for traction. So confident were the patentee and his friends of his success, that they sold all their horses to avoid loss by their reduction in value.

Then follow Edgworth, 1770; James Watt, 1784, who appears only to have specified to prevent piracy, as he considered the boilers were unfit to bear the requisite pressure of steam; Pratt, 1810; Blenkinsop, 1811; Chapman, 1812; Reynolds, 1816; Barry, 1821; Cayley, 1825: Easton, 1825; Clive, 1830. Up to this date the only ideas of applying steam to agriculture that I can find any record of, with the exception of Major Pratt's, were to travel the locomotives over the land, and draw any given implement in their wake. This was proposed to be accomplished in a variety of ways. But in 1832 two patents were taken out by Heathcote and Saxton, the former for traction by a direct pull on a rope from a stationary engine, and the latter by driving an endless rope, and with this rope giving motion to a windlass, to which the implements were to be attached. Heathcote's patent was, I believe, carried out by Mr. Parkes. After this date, various schemes follow similar to those before mentioned, interspersed with schemes for giving motion to agricultural implements by hydrogen gas, by compressed air, by electricity, and even by a portable windmill. In 1836, Vaux (followed by Hall in 1842, and Bonser in 1846) took out patents for revolving cultivators or harrows, though not specifying the way in which they were to be driven by steam-power, and this is the first record in the Patent Office of any such implement, though I believe the Norwegian harrow must have been known before that date.

Following these, we have an endless variety of modifications of the previous plans, presenting no marked novelty, but interspersed with some improvements in details, which rendered them more practical—as Claussen's, in 1846, for an arrangement of pulleys for conveying power to a long distance by an endless rope, for agricultural and other purposes (though agricultural purposes seem to have been second in importance to the propulsion of boats). Osborne, also, for two engines travelling along each headland winding-up chain or rope, as carried out by Lord Willoughby d'Eresby. In 1847, appears the first plan for a locomotive engine-working rotatory cultivator, which Usher and "Talpa" have since rendered so familiar to us, and for which an endless variety of patents have since been taken out, interspersed with engines working hoes, spades, &c., but which, I fear, will exhaust strength and ingenuity that might be more profitably applied in a more practical direction.

The six classes previously named include all the schemes of which we find any record in the Patent Office, and I have been unable to obtain any other information, though I have no doubt many plans and schemes may be found scattered through the periodicals of the last fifty years, but as far as any practical purpose is concerned, this is I think, all that we can require to elucidate the subject.

The present position of steam cultivation may be considered as having been fully represented at the Carlisle meeting of the Royal Agricultural Society in July last, by the machines exhibited there in competition for the society's prize, and by the plans so spiritedly carried out by Lord Willoughby D'Eresby and Mr. Mechi. Four out of the six classes were represented at Carlisle: No. 1, by Mr. Boydell's steam horse, that attracted so much attention from its elephantine movements, and which, though, I believe, useless as a mere means of traction for agricultural implements, yet may in time help us materially to a solution of the difficulty involved in performing the cartage of a farm; No. 2, by Usher's, for though many of the schemes for locomotive engine-working rotatory cultivators vary considerably in detail, yet they all agree in the main principle of a rotatory barrel, driven by the engine, to which, of course, different kinds of forks, spades, &c., varying with the nature and condition of the soil, may be attached. I do not think attaching ploughs to the barrel, as in Usher's, is likely to be the best mode of using the power.

No. 4 may be considered to have been represented by the draining plough, for though draining is a much heavier and more difficult operation than ploughing, and more power being required in one spot, may be thought better adapted to steam power than the ordinary field operations, yet a trial that has taken place during the last two months has proved its much more easy adaptability to the lighter work.

Class No. 5 was well represented by the Messrs. Fiskens' plan, which for light field operations was the only machine that approached a practical result.

Class No. 4 can hardly be said to belong to steam cultivation, as the mode of applying steam to them was yet to be devised.

Class No. 6 was not represented at Carlisle at all, and is only an idea (I believe a very valuable one) thrown out by Mr. Atkins, of Oxford; and, though provisionally protected, was not specified, but allowed to drop, and is, therefore, now open to the public.

I shall now beg to call your attention to that branch of our subject relating to field operations; and, as the locomotive solely used for traction belongs more properly to the carting of a farm, shall dismiss that for the present.

There are various schemes patented in the last few years for rotatory cultivators, worked by locomotive engines, all varying only in detail; and it has been the favourite subject of many of our agricultural writers; but I believe a little consideration would have spared them all much pains and expense, as, if there is one point more difficult than another from which to approach our subject, it is in this direction. The enormous weight of engines required in which an ordinary farm pressure of steam is used, and the weight necessary to give sufficient strength to the drums and frames; the difficulty of steering such a great load to the nicety required for field operations; the yet unknown difficulties that may meet the rotatory cultivator, though, at first sight, I confess it appears well adapted to the work, to say nothing of the power wasted in moving such a weight over arable land, and up ever so slight an incline, might well deter the most sanguine from any attempt of this kind; but it seems, from the Records of the Patent Office, such a monomania at the present

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moment, that I do not think it will be waste of time to endeavour to direct the energies of my brother inventors to a different channel. Were I to undertake to make one of these engines, I should first endeavour to make a simple engine, to be used for the cartage of a farm, making it as light as possible, by the use of high pressure steam, and rendering it perfectly manageable for carting manure, corn, harvesting, &c.; overcoming all the practical difficulties resulting from vibration, &c.; and, at the same time, I should test the value of the rotatory tillage, by driving a rotatory cultivator from a stationary engine, by the use of endless ropes, as proposed by Mr. Atkins, and exemplified by Messrs. Fisken, at Carlisle. Then, should the combination of the two appear desirable, which is very doubtful, it might be accomplished with some chance of success. At present it will only bring with it bitter disappointment and wasted energies.

Of course, with these views, I consider the drawing an agricultural implement by employing a locomotive for direct traction, a still more roundabout and ridiculous plan.

For field operations, we have, then, but two plans that can be considered as coming into competition, both of which have, in common, the important consideration of proposing to use any ordinary portable farm engine; both propose to drag any given field implement that may be attached to them, such as a combination of ploughs, harrows, drills, &c., but they differ in the means by which they accomplish the end in this respect. The one draws the implement by the direct traction of a wire rope, and the other by conveying the power from the engine to a windlass by an endless rope, the windlass winding itself up and down the field by winding up and paying off from two drums a wire rope, anchored at each end, or winding along a wire rope, as may be found best. I must premise my remarks on the merits of these plans by saying that I am myself a patentee of one of them, and had I not thought mine the best, I should not have entered on the competition, and I must leave you to judge of their respective merits, after giving you the reasons that led me to that preference. We will first consider the plan of travelling the windlass up and down the field. A small hemp rope is passed round the fly-wheel of a portable engine, placed in one corner of the field, one end being carried round a pulley at the opposite end of the same headland, and again round a pulley at the top of the furrow to be ploughed. It is then taken to the bottom of the field round another pulley at the bottom end of the same furrow, and again brought up the field to the top of the furrow, where passing round another pulley, it is attached to the other end of the rope, passing round the fly-wheel. In its passage up or down the field, it conveys power to a windlass by its friction on a pulley or series of pulleys mounted upon it, and, being set in motion, turns one or two drums mounted on the windlass, and either winds up or pays off two wire ropes, or winds up and pays off a single rope, winding along that rope by friction. The rope that conveys the power is supported at intervals by carriages, and, in order to convey the necessary power, must be made of hemp, and from its great length and the difficulty of supporting it, requires to be very small. As lightness is necessary, speed is also a requisite. It will have to travel at least one-third of a mile per minute to convey seven horse-power to the windlass, but, circumstances being favourable, almost the whole of the power is conveyed to the windlass, the loss by friction being very slight indeed. Any derangement of the pulleys, however, would, of course, at that high speed, consume any amount of power. The windlass, if made strong enough to wear well, with the drums and gear necessary to reduce the speed, cannot weigh less than 30 cwt., and the power required to draw that weight over the land cannot be less than one-horse draught; assuming the friction of engine, pulleys, and windlass, at half-horse power, we have one-and-a-half horse-power consumed in keeping the machine in motion.

Some experiments I have lately made on the friction of wire rope on the land, show that rather less than two-horse power is required to drive engine, windlass, and wire rope enough to work 20 acres of land (nearly a mile in length), the rope travelling at 2½ miles per hour, and being strong enough to pull up a ten horse engine at that speed. Thus we see that the advantage as respects friction is not greatly in favour of the former plan. The disadvantage of the windlass travelling up and down the field is very great, though the plough may be attached to either end of it, and ploughing may be thus easily performed, yet, if you wish to pull any other farm machine when you get to the headland, you have no means of getting the implement to the opposite side of the windlass and going back except by the assistance of horse-power, and this, as will be seen, does not apply to the simple rope, by which the implement can be easily turned. I think, with these disadvantages, the plan of traction by winding up a wire rope is greatly preferable, as it is much simpler, having fewer wearing parts, is less liable to derangement, and more easily managed. The wear and tear on a hemp rope, at such a speed, and exposed to all sorts of weather, is a point on which I am not competent to form an opinion, but former experience would lead to considerable doubt on this point. Before proceeding to describe the two plans for traction, to which I shall call your attention, it will be well to consider what have been the causes of failure in the previous attempts of Heathcote, in 1837, followed by Osborne and Lord Willoughby D'Eresby. In the experiments that Mr. Parkes, the well-known draining engineer, tried for Mr. Heathcote, the difficulty experienced was, to procure any material that would convey the requisite power without entailing too much weight and consequent friction on the land, and I understand that the material he found best adapted to the purpose were steel-bands, riveted together at the ends. Lord Willoughby D'Eresby, in the use of chain for that purpose, effectually prevented the possibility of success in his efforts, as the friction of chain on the ground is so great that it would consume almost more power than it is capable of bearing, when of any great length. The present perfection to which the manufacture of wire rope has attained, has, however, entirely overcome the difficulties that beset *them*; and in Mr. Williams's and my own plan, wire rope is the only material with which we propose working. Mr. Williams proposes to mount an ordinary portable engine on a frame, on one end of which two barrels are fixed, turned by the engine, by one of which a wire rope is wound up, and passed off by the other; one end of this wire rope passes straight down the field, and the other passing along the frame at right angles to the drum for some distance, and then down the field again, running along the frame anchored at the bottom, and meeting the other rope. The implement to be drawn is fixed between the ropes, and alternately pulled backwards and forwards by these ropes, the two frames being moved along the headlands as the work progresses. My own plan is to mount two drums on a frame, fixing them in one corner of the field, the portable engine being set so as to drive them with a short rope or chain working in pulleys. The ropes are led off the drums to opposite corners of the field, and there pass round pulleys, anchored on a chain stretched between two posts or anchors, and the drums, being alternately set in motion, wind the wire rope backwards and forwards between the two pulleys: which are moved up the field by being allowed to slip along a chain stretched between two posts or anchors as the work progresses, the engine and windlass remaining stationary until the whole field is completed.

My reason for preferring this plan is that I consider the number of pulleys in Mr Williams's unnecessary, and injurious to the rope, as well as consuming power; and the fixing the windlass and engine on one frame, and moving them along the headland is unnecessary, expensive for first cost, and extremely cumbrous. To these remarks I may be allowed to add that one of my windlasses has been at work for the last six weeks at Mr. Smith's, of Woolston, near Fenny Stratford, who will be able to give you the results of his experience. I believe that either of the above three plans is capable of solving the problem of the application of steam to field operations, and Mr. Smith's experience would fully justify me in saying that it may be done at a saving of 40 per cent. over horse labour. Mr. Smith's calculations are as follows:—four men and boy will plough an acre in 2½ hours, or 4 acres a day. Thus only the same number of men are required as for horse labour, consequently, we have all the horse labour saved, which deducting the cost of 7 cwt. of coal, gives a saving of nearly half, as the wear and tear will hardly exceed the wear and tear of eight horses. Another advantage he considers must not be lost sight of, is that the land is not injured by the treading of the horses in wet weather, and, consequently, he can work it when he otherwise should be at a stand-still.

Having thus, I think, arrived at the conclusion that any given implement may be drawn over the land by an ordinary portable engine, it will be necessary to consider what implements are likely to be best adapted to be used with this tackle, so as practically to make it most serviceable. Ploughing, of course, is the ordinary operation of a farm, and a series of four or five ploughs, fixed in a frame, will at any rate best meet the present wants and prejudices of the farmer. Mr. Williams has invented a series

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of ploughs that have very considerable merit, and I have no doubt that but little difficulty will be found in adapting ploughs to meet the requirements of the farmer. I think there is every probability that some other implement will, to a great extent, supersede the plough, and to this attention ought now to be turned. Mr. Smith is now, and has been for some years, moving with horse-power, a sort of grubber, instead of the plough, and with, I hear, the best results. But I must confess I see no way of effectually and thoroughly turning over the soil, which is often necessary, both to expose it to the air and bury the stubble and weeds, but by the use of the plough. Still this operation can hardly be necessary very often in a year, and I believe a machine may be made which will take the soil up on a platform to a certain height, then, passing it through revolving harrows, leave it at once in a perfect tilth, and which may be worked by traction.

This would offer great advantages, as the soil is often, when broken up, in a fit state to pulverise, but, after the sun's rays have heated it for a few days, it is quite impossible to break it. The sets of implements that may be found best for different soils and circumstances to be worked by steam-power, will be numbered by hundreds; and it is impossible for me to estimate the changes to which the application of steam may give rise, nor will my limits permit me to dwell longer upon it. It is worthy of serious and careful attention, and, I think, deserves at once to be the subject of extended experiments.

I have now to notice the working of a revolving cultivator by an endless rope, and, should experience prove that a rope used in this way is sufficiently durable for the purpose, I should think most highly of this plan. If ever rotatory cultivation is to be brought to bear, I feel sure it will be in this way, and, with the former proviso, I have no doubt experiments in this direction may lead to practical results of great value. It is simple in working, the experiments need not be expensive, and they have a fair prospect of success.

Having thus drawn your attention to what appear to me to be all the most practicable schemes and experiments for performing field operations by steam, I now have to refer to the other branch of our subject, the cartage of material to and fro on a farm. A large team of horses will still be required on a farm to do the necessary carting, going to market, &c., but during harvest every available horse is often required, especially on large light land farms. Can our windlasses be made available for harvest work; if so the number of horses might safely be reduced two-thirds. The practice of ricking in the field is now common, and where this is the case, there can be no difficulty in using the windlass to bring the corn to one spot. You might fix the windlass in the morning, and clear a 20-acre field with it in a short time. It can be removed and fixed again with ease in two hours. The windlass could be also used for carting turnips, but if a traction locomotive could be made available, it would be far better suited to the work. A tramway down the centre of the farm, using the windlasses to the right and left to bring material to the tram, would reduce the horse work to a minimum, but whether the locomotive could not be made to do the carting work of a farm is well worthy of attention. I am assured by Mr. Worby, who made experiments some thirty years back on the subject, that it is perfectly practicable. He has had forty years' experience in the various farm implements with which we are acquainted, as manager for Messrs. Ransome, and may be assumed to know what practical difficulties are likely to lie in the way. The great difficulty met with by Hancock, and others, on common roads, was the speed at which they travelled, but for this purpose three miles an hour will be a sufficient speed. I believe that a few experiments would lead to a successful solution of this problem. One essential to its success is, however, the use of very high-pressure steam, so as greatly to reduce the weight of the engine, and consume as little water as possible. This has been pretty much reduced to practice lately at a mill at Navestock, belonging to Mr. Hall, and in a portable engine which he is using, in both which engines steam of nearly 300 lb. pressure is used. These machines were made by his son-in-law, Mr. Charlton, and have been in work during two years. One difficulty that has beset this subject, the impossibility of driving two wheels, is now overcome by a very simple contrivance, which I am not at liberty to describe to you, and this is a great step in the right direction. Boydell's wheels, also, may form an important auxiliary in certain states of the weather, though I think they would hardly do in constant wear. Were I to attempt the solution of this question, I should use wheels to which Boydell's rail could be attached whenever the state of the weather demanded. Thus there three directions in which, in my judgment, it would be well to make some experiments; 1st, in implements adapted to be worked with the steam windlasses; 2nd, in a rotatory cultivator, worked by a portable engine, with endless band; 3rd, in a locomotive used for traction to do the cartage of a farm.

I feel confident that a few well-directed experiments, in either or all of these directions, would bring out good practical results in the course of a few years; but I would ask you whether it is right that the carrying out of these experiments should be left to chance, whether, when so important a matter is involved as the rapid development of steam cultivation, it would not be wise to enlist the public in the endeavour to bring them to some practical solution. If left in private hands it may, and probably will, take many years to arrive at any real results, and at the cost of loss and disappointment to many of a deserving but unfortunate class of men; whereas I feel confident that with public assistance, a short time would enable us to solve both the three questions that at present seem most to claim attention, and others that no doubt would arise in the course of prosecuting these inquiries.

REVIEWS

The Illustrated Handbook of Architecture; being a concise and popular account of the different Styles of Architecture prevailing in all Ages and Countries. By JAMES FERGUSSON, M.R.I.B.A. London: Murray, Albemarle-street. 1855. [Second Notice.*]

In drawing attention to this work in our last number, we endeavoured to give an epitome of the author's views generally, touching the principles and practice of architecture, as expounded in his comprehensive "Introduction;" we have now to explore the volume itself, and especially such portions as bear on the progressive and local features of the art, and on the opinions which have been deduced from them. It could have been wished that some more strictly chronological arrangement had been followed throughout; but there were difficulties, as the author has explained, which would have necessitated frequent and abrupt interruptions to the continuity of the narrative, while in the course adopted—which is a combination of the chronological and locally historical—except in one or two instances there are no chronological inversions of any importance, nor any very marked instances of interruption. By separating all architectural objects into Christian and non-Christian (usually called Pagan), we obtain two great divisions very nearly equal in the importance of the objects described, and very readily distinguished from one another. As the Christian styles in every case arose out of the Pagan, which are almost invariably the older, the Pagan of course takes precedence; and if antiquity alone were considered, the Egyptian ought to be the first described: but, in that case, after going through that style and the Assyrian, which comes next, we naturally pass to the Greek and Roman, and the narrative must then be broken to make way for the Indian, the Mexican, and other styles which have no connection either with those which preceded or which followed, in other parts of the world. To avoid this, a classification of a more topographical nature has been adopted; and commencing from the East, all those styles which have no internal relation with those of the West are first described, next an almost equally independent group in western Asia, and then follow in succession, the Egyptian, Grecian, Roman, Sassanian, and Saracenic; this completes the first division. The second embraces the Romanesque,—Lombardic and Rhenish,—Gothic, as developed in France, Belgium, Germany, Italy, Portugal, Great Britain, and northern Europe,—and the Byzantine styles.

It will be noticed that one great division of the subject finds no place in this list, viz., the Palladian or revived Italian, which has more or less prevailed all over Europe during the last three centuries and a half, and we are at a loss to conceive any reason for its omission. Mr. Fergusson does not, like some recent writers, ignore it as unworthy of attention, for in the very few words with which he dismisses the reference, and which we quote, he describes it as "infinitely inferior to the Gothic, which preceded it, as an artistic form of art, but nearly as important from the size and splendour of the buildings in which it is employed, and fully as interesting to the philosophical student of the subject, not only for what it teaches, but because it is an

* See *Journal*, *ante* p. 68.

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index to the mind of Europe during the period in which it prevailed, and is the lesson which all must study who would attempt to understand the noble art of architecture."

India, as may be imagined, occupies a prominent and interesting position in our "Handbook." A country so completely detached from the other kingdoms of the ancient world, and of whose modern condition so little is structurally known, deserves an analytical notice; and the many engravings interspersed, from sketches by the author, greatly facilitate the apprehension of the text, and add to the value of the work. In any attempt to understand either the history or the arts of India, it is important to bear in mind that the population consists, as it has always done, in historical times at least, of two races of men widely differing the one from the other:—the Tamul race, inhabiting the southern part of the peninsular, and that race, which, from various western sources, first settled between the Indus and Ganges, and which afterwards progressed eastward to Calcutta. Owing to the very spirit of their religion, this latter class were not temple builders. They would have thought it impious to rear with human hands a house for the one Great Spirit of the universe, as was the case in Persia, where, even when Darius had learnt from more western nations some notions of architectural magnificence, the buildings which were raised were palaces rather than temples. The Grecian temples were borrowed from Egypt; the Roman from Greece and Etruria; and our own from Rome.

Among the early Indian tribes it would, therefore, be vain to look for any monuments of importance. It was not till the the seventh century before the Christian era that the Buddhist religion was introduced, and, consequent on this change, was the elaboration of a style of architecture the most ancient as well as the most interesting of those whose monuments are found scattered over the plains of India. By way of general classification of these remains, the author divides them into Topes, Temples, and Monasteries. Under the denomination 'Topes,' are included the most important buildings, consisting of detached pillars, towers, and tumuli, all of a sacred or monumental character. A large proportion of these were monoliths, alike in form, and with the same inscription on each, alluding to the creed and principal Buddhist doctrines; and one from Allahabad, which is engraved as a specimen, is very curious, as exhibiting in its neck enrichment the honeysuckle and lotus ornament, here said to be derived from the Assyrians, but in essential character precisely like that so frequently used by the Greeks.

The external appearance of ancient temples is a matter of conjecture only, no architectural ruin or delineation being now extant to give evidence on the point; thus a link is wanting in the history, which is so far to be regretted: otherwise, the rock-cut examples are numerous and unusually perfect. "It may be assumed that certainly more than forty, and probably nearly fifty, groups of caves exist in India Proper." Some of these groups contain as many as 100 different and distinct excavations; others not more than ten or a dozen, but the author reckons that not less than 1000 distinct sub-divisions are to be found. The well-known cave at Karli, near Bombay, is shown by plan, section, and view, and diagrams are given of those at Ajunta, Cuttack, Ganesa, Baugh, and Salsette. The cave of Ajunta is further detailed by sketches of two of its pillars, which start square, as cubes, from the ground, then set back for a similar height octagonally; above which, up to the necking, they take a fluted polygonal form (apparently of sixteen sides); the order is then reversed till they are gathered back into the original square, which, in two heights, constitutes the capital. Simple as is this conception, the effect is exceedingly good, and enhanced by slight enrichments. One very curious peculiarity of the earliest caves in India is, that they only, of all the buildings or caves of that country, possess the sloping doorway, narrower at the top than at the bottom. This shape is usually called Egyptian, though not found in that country, but it does exist in Etruria, in Ethiopia, in ancient Greece (at the Erechtheion), and in Asia Minor. This fact, coupled with the honeysuckle ornament just referred to, and with which it is usually found in conjunction, opens a curious field for investigation, and probably important discoveries.

Under the head of "Monasteries," Mr. Fergusson gives an excellent and succinct an account, and one which throws so much light on the general subject, that we shall transfer it entire to our pages:—

"It is probable that the cave-monasteries differ far more widely than the temples from their built originals. The number of priests in the most flourishing times of Buddhism appears to have been enormous. Its records show that it must have exceeded that of Roman Catholic monks in the middle ages. In fact no religion probably ever indulged in a more excessive priesthood, and none ever more certainly sank beneath the weight of its indolence and corruption. We may conclude from this that the number and size of the monasteries was very great; and we have reason to believe, both from descriptions and tradition, that many of them were buildings of several stories in height. It is true that we have very slight traces of this in the cave-monasteries; for in most instances, even where we find them in two or three stages, one above the other, they are distinct excavations and have no connection one with another. The caves are moreover limited by the necessity of admitting light from the front only; and none of them contain more than a central hall with its surrounding cells. Nor of course do the caves give any idea of what the exterior of the originals may have been, of which therefore we can only affirm that they must have been important and imposing objects.

The general purposes of both the temples and the monasteries are perfectly well known. Any one who has seen Buddhist priests celebrate either matins or vespers, or some of their more pompous ceremonies, will at once understand the use of every part of the edifices we have been describing. To those who have not witnessed these ceremonies, it will suffice to say that in all the principal forms they resemble those of the Roman Catholics. It is beside the purpose of this work to trace the source of this resemblance, which has attracted the attention of every Roman Catholic priest or missionary who has visited Buddhist countries; from the earliest missions to China to the recent journey into Thibet of Messrs. Huc and Gabet. All they can suggest by way of explanation is, 'que le diable y est pour beaucoup.'

The same is true with regard to the monasteries. At the time when they were excavated, Buddhist priests were, as now, sworn to celibacy and poverty, and lived apart from their fellow-men in monasteries devoted wholly to religious observances. They shaved their heads, wore a peculiar garb, and obtained, like the mendicant friars, their subsistence principally by alms, which they collected by begging from house to house. Their principal duties were the study of the law and precepts of Buddha, and the continually recurring performance of an unmeaning ceremonial, in which the laity took no part. In some instances these ceremonies were performed within the monasteries themselves, which were all in later times provided with one or more chapels, containing images of Buddha or of subordinate saints, before which their prayers were repeated. But in earlier times, at least, the monasteries were always in the immediate neighbourhood of temples; from which we may gather that either the monasteries were mere residences, and all the services were performed in the temples; or that the great and solemn acts of worship took place in the temples, while the ordinary daily devotions were celebrated within the walls of the monasteries themselves.

It has been already said that the monasteries are far more numerous than the temples. From 700 to 800 examples are known at the present day, and probably there are many more. In age they extend from the simple and unadorned cells excavated by Dasaratha, the grandson of Asoka, about 200 B.C., in the granite rocks at Behar, nearly to the time of the Mahometan conquest. The culminating point, however, of this style of art, was shortly after the Christian era; the greatest number, certainly the best, having been excavated during the first five centuries after the birth of Christ."

In a subsequent page we find the following description of monasteries in Burmah:—

"As Burmah is a country in which the monastic system of Buddhism flourishes at the present day to the fullest extent, if we had some information regarding its monasteries, or *kioums* as they are called, it might enable us to understand the arrangement of the older ones. The travellers who have visited the country have been silent on the subject, principally because the monasteries are, in almost all instances, less magnificent than the pagodas to which they are attached, and are, with scarcely an exception, built of wood—a practice destructive of their architectural character, and also depriving them wholly of that monumental appearance of stability which is so essential to true architectural expression.

This peculiarity of being of wood is not confined to the monasteries; all residences, from that of the poorest peasant to the palace of the king, having been constructed from time immemorial of this perishable material. The custom has now passed into a law, that no one shall have the power of erecting buildings of stone or brick, except it be the king himself, or the edifices be of a purely religious character. Nor is this exception taken advantage of, for the king's palace itself is as essentially a wooden erection as the dwelling of any of his subjects. It is, however, not the less magnificent on this account—rather, perhaps, more so—immense sums being spent on the most elaborate carvings, and the whole being lacquered, painted, and gilt, to an extent that we have no conception of in our more sober clime.

The fact that all the buildings of Burmah are of wood, except the pagodas, may also explain the fact of India possessing no architectural remains anterior to the age of Asoka. Except the comparatively few

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masonry pagodas, none of which existed prior to his era, there is nothing in Burmah that a conflagration of a few hours would not destroy, or the desertion of a few years entirely obliterate. That the same was the practice of India is almost certain, from the essentially wooden forms still found prevailing in all the earlier cave temples; and if so, this fully accounts for the disappearance of all earlier monuments.

We know that this wooden architecture was the characteristic of Nineveh, where all the constructive parts were formed in this perishable material; and from the Bible we know that Solomon's edifices were chiefly so constructed. Persepolis presents us with the earliest instance in Asia of this wooden architecture being petrified, as it were, in consequence apparently of the intercourse its builders maintained with Egypt and Greece; but in the remote lands we are now describing the old Asiatic type of art remains unchanged in all its ephemeral splendour to the present hour; bad and barbarous, it must be confessed, as a style of art, yet not wholly without interest from its historical bearing upon other styles."

After India and Burmah, Java, Thibet, and Nepal, come under consideration, as presenting phases of Buddhist architecture; and finally, Jaina, and the transitional styles. China and Japan, other countries in which this species of architecture is found, are treated of separately, as in them it is greatly modified by peculiar idiosyncrasy. Some valuable information is given with regard to the construction of the masonry in these buildings, and their domes and mode of roofing, and in summing up this section of the work, it is remarked,—"Whatever doubt there may be of the merit of Buddhist monuments as works of art, there can be none of great historical value; for, of the styles still practised, it is the oldest, having been constantly in use for more than 2000 years, and it is the style of a religion which, even at its present hour, when its greatest glory has passed away, still reckons among its votaries, if not a greater, at least as great a number of followers as any religion now existing on the face of the globe."

The second book is wholly devoted to Hindu architecture, divided into three styles, distinct yet cotemporary, viz., Southern, Northern, and that which prevailed only in Cashmeer and the Punjab. Of the northern Hindu style we have very few remains, but there is perhaps no country in the world where temple-building has received so extraordinary a development as in the south. For the amount of labour bestowed upon them, and their extent, they appear to rival Karnac and the most extensive temples of Egypt, and surpass, in the opinion of the author, even the cathedrals of the middle ages in complexity of design and variety of detail; viewed, however, as works of art, they are greatly inferior. The minute description of these temples as to their plans and arrangement, and even subordinate features, is such as could be indited only by one fully conversant with the subject, and this completeness of treatment stamps a peculiar value on the essay. Like in other portions, the text is materially assisted by numerous careful engravings. That of the Gopura at Combaconum, and the plan of the temple (comparatively modern) at Tinnevelly, which shows a hall containing 1000 columns, are most noticeable, The well known Kylas, or rock-cut temple at Ellora, is not forgotten. The author says that—

"Considerable misconception exists on the subject of cutting temples in the rock. Almost every one who sees these temples is struck with the apparently prodigious amount of labour bestowed on their excavation, and there is no doubt that their monolithic character is the principal source of the awe and wonder with which they have been regarded, and that, had the Kylas been an edifice of masonry situated on the plain, it would scarcely have attracted the attention of European travellers at all. In reality, however, it is considerably easier and less expensive to excavate a temple than to build one. Take, for instance, the Kylas, the most wonderful of all this class. To excavate the area on which it stands would require the removal of about 100,000 cubic yards of rock, but, as the base of the temple is solid and the superstructure massive, it occupies in round numbers about one half of the excavated area, so that the question is simply this—whether it is easier to chip away 50,000 yards of rock, and shoot it to spoil (to borrow a railway term) down a hill-side, or to quarry 50,000 cubic yards of stone, remove it, probably, a mile at least to the place where the temple is to be built, and then to raise and set it. The excavating process would probably cost about one-tenth of the other. The sculpture and ornament would be the same in both instances, more especially in India where buildings are always set up in block, and the carving executed in situ. Nevertheless the impression produced on all spectators by these monolithic masses, their unalterable character, and appearance of eternal durability, point to the process as one meriting more attention than it has hitherto received in modern times; and if any rock were found as uniform and as easily worked as the Indian amygdaloidal traps, we might hand down to posterity some more durable monument than many we are now erecting at far greater cost."

The view of the hall in the palace, Madura, strikes one as exhibiting a close affinity in its piers and the form of its arches to our European Gothic; the roof, too, partakes of the same feeling. Whether these are strictly in accordance with the original, or owing to the sketchy hand of the artist (the woodcut is taken from Daniell's 'Views in Hindostan'), we of course cannot decide; but, if correct, the coincidence is remarkable. Among the suggestive engravings with which the work abounds, may be mentioned the "Balcony at the Observatory, Benares" (p. 120), formed by a projection on the lower story, from the front and sides of which, above, overhang bold corbels, supporting the projecting window and balcony in a simple and pleasing manner. These balconies have an excellent effect in relieving the monotony of the plain face of a building, without interfering with its main lines, or requiring any great constructive skill. Another object of architectural magnificence peculiar to northern Hindostan, is the construction of the *ghâts* that everywhere line the river banks in most of the great cities, more especially those that are situated on the Ganges. Their object being to afford easy access to bathers, the flight of steps in front is in reality the *ghât* and main building itself. These are generally broken by small projections, often crowned by kiosks, which take off the tameness inherent in long lines of narrow steps. This flight of stairs is always backed by a building, which ordinarily is merely a medium of architectural display, without any particular destination, except to afford shelter from the rays of the sun to such of the idle as choose to avail themselves of it. When the bank is high, the lower part of these buildings is solid; or, if nearly plain, it affords a noble basement to an ornamental upper story, with which they are generally adorned, or to the temple which frequently crowns them. The following extracts from the recapitulation of the subject will afford us additional information.

"The history of Indian architecture commences not earlier than the middle of the third century before Christ, when Asoka made Buddhism the state religion of India, and sought to commemorate the fact, not only by inscriptions, but by monumental columns and other lasting memorials, some of which remain to our day. It then begins with a strong admixture of Grecian, or at least of Western art, as if the Indians were then first learning from foreigners an art they had not previously practised; but this extraneous element soon died out, and is not again to be traced, except perhaps in Cashmeer, where it seems to have long remained in force.

From the time of Asoka till nearly that of the Mahometan conquest there exists no difficulty in tracing the whole history of Buddhist art—a complete series of examples existing in the caves and topes; which, taken in connection with those of Afghanistan and Ceylon, and other buildings, amply suffice to elucidate the subject. From that time to the present day we find abundance of examples in Burmah, Thibet, and Nepal, which, with collateral illustrations from Java and elsewhere, enable us to trace the history of the Buddhist style through more than 2000 years. There is every reason to believe that from the buildings themselves, and from the paintings and sculptures with which they are adorned, the whole history of this important sect may be restored with the utmost distinctness and certainty.

In India this style was succeeded by that of the Jains, though this latter seems scarcely to have arisen out of the former, but to be the lineal descendant of some older style whose traces have not yet been detected farther back than the ninth or tenth century, though some may probably still exist between India and the western parts of Asia. If the Jaina buildings want the manly vigour and boldness of the Buddhist style, they far surpass it in the elegance both of their combinations and of their details. In these respects the Jaina style surpasses any other style in India, and has had in consequence more influence on the Mahometan art, and, through it, on the modern Hindu, than any other—circumstances which would render its study singularly interesting, had we the means available for its prosecution. At present, however, they do not exist; and from the circumstances of none of the great kingdoms of India having ever adopted the Jaina as a state religion, its traces are only discovered in the more remote corners of the country, where they have hitherto generally escaped the notice of travellers.

The principal Hindu style arose in the south among the aboriginal Tamul races, and extends north as far as Ellora. We do not know at what age it first was practised, no example having yet been traced to so early a date even as the fourth or fifth centuries after Christ. When it first appears, it seems to have adopted Buddhist forms, or at all events to have arisen out of the same forms from which the Buddhists elaborated their style. Hindu architecture continues almost unchanged to the present day, except that the Mahometan influence is sometimes strong in civil buildings: and cases occur in which a strange mania for copying debased European art has crept even into the sanctums of their

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temples. This, however, is a rare occurrence; and generally speaking it is only in the inferiority of workmanship and design that we trace the influence of age in this class of art.

In Cashmeer there still exists another style, differing from all these, showing, in the first place, a people secluded from the rest, perhaps retaining its earliest forms unchanged, or at all events owning different influences and practising a different art from any of the people around. When properly investigated, it may throw new and unexpected light on this hitherto obscure subject. Much, however, very much, still remains to be done, before the subject of Indian art can either be understood or be placed on a satisfactory footing of scientific induction. No works have yet been published exclusively devoted to the subject, except, I am sorry to say, my own; and mine is imperfect not only from the impossibility of one situated as I was effecting more without aid, but also from the great difficulty of publishing such works in this country, where the subject interests so few. Were the above sketch doubled or trebled in length, and the illustrations increased tenfold—for which materials exist—Indian architecture might rank with the known styles of the rest of the world.

It does not, however, possess either the solid grandeur and simple magnificence of the Egyptian style, or any of that sublime aspiration after eternity that strikes with awe every visitor to the valley of the Nile.

The Indian styles are unrivalled for patient elaboration of the details, which are always designed with elegance, and always executed with care. The very extent of ornamentation produces feelings of astonishment, and the smaller examples are always pleasing from the elegance of the parts and the appropriateness of the whole. In no styles is the last characteristic more marked than in those of India; for whether the architects had to uphold a mountain of rock or the airiest dome, or merely an ornamental screen work, in all instances the pillars are exactly proportioned to the work they have to do, and the ornaments are equally suited to the apparent strength or lightness of effect which the position of the mass seems to require. No affectation, and no imitation of other styles, ever interfere to prevent the purpose-like expression of every part, and the effect consequently is always satisfactory and pleasing, and, when the extent is sufficient, produces many of the best and highest modes of expression of which the art of architecture is anywhere capable.

It may be that persons who have not had an opportunity of studying the buildings on the spot may not be inclined to form so favourable an estimate of the Indian styles as that here expressed; and, indeed, without actual inspection, no sufficient means exist for forming a correct judgment on the subject at all. But whether the architecture be really good or only passable, it is interesting as the art of a large portion of the human family. It affords the only means of judging correctly of the state of civilisation and power of a people whose history is lost, or is so obscure as to be almost illegible. It should also interest the student as showing how numerous and various the forms are which may be used for architectural purposes, and each as appropriate as any of those he is already familiar with; for, though men do not now believe, as they did a few years ago, that there are only five different forms of a pillar admissible, they do not yet know how numerous are the ways in which pillars may be employed. The adaptation of every part to the thousand different purposes to which it may be applied necessarily causes an infinite variety. This in fact is the great secret of architectural propriety, but which the Indian and Gothic architects seem alone fully to have appreciated."

In the commencement of the third book is a short notice of *Chinese* architecture, which is said to exhibit little worthy of the name. The Chinese differ from all European nations, not only by the objects they propose to attain by their arts, and in the forms in which they seek to embody their conceptions, but also in the processes by which they carry them out. No people on earth can carve granite with such facility and precision as the Chinese, and nowhere is skilled labour so cheap, and time so little thought of, as among them. Hence, the absence of art must arise from absence of taste, not want of power. The truth seems to be, that they are a people naturally excelling in constructive talent, and in all technic arts; but wholly devoid of either æsthetic feeling or desire to share in that higher sphere of human utterance. In one respect, however, Chinese architecture is instructive. "They are the only people who now employ polychromy as an essential part of their architecture; so much so, that colour is with them far more essential than form; and certainly the result is so singularly pleasing and satisfactory, that for the lower grades of art, it can hardly be doubted but that it should always be so. It is almost as certain, that, for the higher grades of art, colour, though most valuable as an accessory, is incapable of the same lofty power of expression which form conveys to the human mind."

From China we cross the ocean to America, and halt awhile in its comparatively unexplored regions to glance at Mexico, the country of the Chichemecas and Astecs. The principal remains of architecture in central America are not found in Mexico Proper, but in districts in which the Astecs never obtained a permanent footing, in Yucatan, Chiapas, and Guatemala. As in almost all countries, however, the principal buildings are the Teocallis, or houses of God. These are always pyramids, square in plan, and generally formed into two, three, or more stories or terraces, with a platform on the top, on which the temple, properly so called, always stands. Next to these in importance are the palaces, or houses of the kings, in many respects similar to the temples; and a third class are tumuli or mounds of earth, with sepulchral chambers generally above ground, the openings of which are visible outside. Through the explorations of Mr. Stephens, and the beautiful drawings of his companion, Mr. Catherwood, some idea may be gained of the extent and character of these monuments, and several are depicted in the book before us. Among these is the pyramid of Palenque, about 280 feet square, and 60 feet in height, on the top of which stands the temple. With regard to the construction of buildings ordinarily, it appears that the style may be characterised as one remove from the original wooden construction of early times. Stone pillars have been found even supporting beams which act as springers for stone vaulted ceilings.

Peruvian architecture differs widely from that last mentioned, in the fact that timber would seem to have been used here in primitive times so sparingly that its traces are hardly discernible in subsequent construction. The material employed in the ruder age was mud, of which many evidences now exist; they next adopted a sort of concrete, and lastly, a cyclopœan masonry of great beauty and solidity. In the scale of fine art there is very little to record.

The discussion on Assyrian and Persian exhumations naturally engrosses several chapters. It is a favourite theme with the author, and which he has greatly amplified in his work on the 'Palaces of Nineveh and Persepolis restored,' and from which the main features here given have been culled. Khorsabad, Koyunjik, Nimroud, and the palace of Esarhaddon, are elaborately examined; as also the Birs Nimroud, so long supposed to be the remains of the Tower of Babel, but now ascertained, chiefly through inscriptions found by Colonel Rawlinson, to be the remains of the temple of the Seven Spheres at Borsippa. The extraordinary character of this building as now revealed can only be imagined by consulting Mr. Fergusson's work and by the help of its accompanying diagrams.

In suitable company with these Biblical restorations we meet with treatises on Solomon's Temple, and the ruins at Palmyra. No building of antiquity so much resembled the former of these as the so-called palace of Darius at Persepolis, only that the latter is by far the larger of the two. The second Temple at Jerusalem doubtless stood on the foundations of that of Nehemiah, to which the Temple of the Sun at Palmyra is another building very similar in character. It consisted of a cloistered enclosure of somewhat larger dimensions than that at Jerusalem, measuring externally 730 feet by 715, with a small temple of an anomalous form in the centre. It wants, however, all the inner enclosures and curious substructures of the Jewish fane; but this may have arisen from its having been rebuilt in late Roman times, and consequently shorn of those peculiarities.

Asia Minor comes next under review, calling to memory its once splendid cities of Ephesus, Sardis, and Halicarnassus, and three of its great historical epochs in connection with Troy, Tarsus, and Trebisond. Excepting, however, the remains of the Greek and Roman periods—the great temples of the first, and the great theatres of the latter era—little that is architectural remains in this once favoured land. The important discoveries made since 1838 by Sir Charles Fellowes and others, reveal some insight into Lycian antiquity, and a tomb found here is, it will be remembered, now lodged in the British Museum.

With Asia Minor we conclude our investigation of all the known styles of architecture in the eastern world, and, therefore, now turn westward towards Egypt, and that great band of nations living round the shores of the Mediterranean sea.

The architecture of Egypt divides itself into two great periods, the first represented by the pyramids, and the second by the temples. All chronological systems, however widely differing in the actual dates assigned, concur in placing the pyramids of Egypt as the oldest of all architectural objects, either in existence or of which any record or description whatever is preserved. Yet, with these evidences of extreme antiquity, we are startled to

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find Egyptian art as nearly perfect as in later ages, when Greek science and refinement had been brought to bear on its elaboration and refinement. Think only of the mechanical powers involved in transporting the huge blocks of granite from Syene to Memphis, of squaring them with a mathematical accuracy never surpassed, of polishing them to a surface smooth as glass, and of raising them higher than such blocks were ever raised in any buildings in the world, and setting them there with so wonderful a precision, that, after thousands of years have passed over them, there they yet remain without flaw or settlement! As examples of technic art they are unrivalled among the works of men, but they rank among the lowest if judged by the æsthetic rules of architectural art. The same character belongs to the tombs and buildings around them; they are low and solid, and possess neither beauty of form nor any ornamental feature worthy of attention or admiration, yet, like the pyramids, in evidences of lasting stability they have attained the object their builders had principally in view when they designed them. The moment we pass the local limits of the necropolis of Memphis, we become aware of the presence of a new style of architecture, differing in almost every respect from that which preceded it, and in many respects remarkably antagonistic. No longer do we see pyramids, or traces of quaint wooden structures,—but, in place of these, everywhere obelisks and temple-palaces. The simple grandeur they evince is universally owned, and their almost unvarying characteristics are familiar too, but of their enormous size or extent nothing but an actual survey can afford a true conception. The temple of Karnac, Mr. Fergusson designates as "perhaps the noblest effort of architectural magnificence ever produced by the hand of man;" the principal dimensions being 1200 feet in length, by about 360 in breadth, covering therefore about 430,000 square feet, or more than twice the area of St. Peter's at Rome. It must, however be recollected that our modern buildings are all under one roof, which was not the case of old; a considerable portion at Karnac was quite uncovered. The temple at Luxor is another work of overwhelming grandeur; and, besides these, there stood on the western side of the Nile, the Memnonium or great temple of Amenophis III., now almost entirely ruined, owing to the marshy site on which it was built.

After a long period of misfortune and decay, from which she was recovered by the enlightened policy of the Ptolemies, Egypt presented in her architecture a like revival; not to an equal purity with the great national era, but still with much richness and splendour. Of edifices erected at this later period may be mentioned the temple at Edfou, usually known as Apollonopolis Magna, those at Dendera, at Kalabsche, and at Philœ. There are also not a few curious rock-cut temples both in Egypt Proper and in Nubia; also many excavated labyrinthine tombs of mysterious solemnity. Of domestic architecture very little remains; but in paintings and sculpture so many illustrations have been handed down to us that there is no difficulty in forming a correct judgment both of its style and details. There is every reason to believe that the cities which have passed away were every way worthy of the temples that adorned them, and that the streets were as splendid and tasteful as the public buildings themselves, and displayed, though in a more ephemeral form, the same wealth and power which astonish us in the great monuments that remain. Taken altogether, perhaps it may be safely asserted that the Egyptians were the most essentially a *building* people of all those we are acquainted with. The Greeks, it is true, surpassed them in refinement and beauty of detail, and in the class of sculpture with which they enriched their edifices, and the Gothic architects far excelled them in constructive ability; but neither Greek nor Gothic architects understood more perfectly all the gradations of art, and the exact character that should be given to every form and every detail. Mr. Fergusson claims for the Egyptians a knowledge of the principles of the *arch*, stating that "many of the tombs and chambers round the pyramids are roofed by stone arches of semicircular form, and perfect in every respect as far as the principles of the arch are concerned." Afterwards we read—"In Ethiopia, Mr. Hoskins found stone arches vaulting the roofs of the porches of the pyramids, perfect in construction, and, what is still more singular, showing both circular and pointed forms. These are probably not earlier than the time of Solomon." * * * "It would, indeed, be more difficult to account for the fact of such perfect builders as the Egyptians being ignorant of the arch, if such were the case; though, at the same time, it is easy to understand why they should use it so sparingly as they did in their monumental erections." We have dwelt thus at length on the primitive and less known styles of architecture, both for the reason that they are such, and because in them may be traced the germs of subsequent art in every age and country.

The next topics to which we are introduced are Grecian and Roman architecture, occupying upwards of 100 pages. These are clearly written, and include many ingenious historic theories, as well as practical descriptions. Recurring to the "arch" question, it is suggested that "it does not seem to have been so much want of knowledge that led these early builders (Pelasgic) to adopt the horizontal in preference to the radiating principle, but a conviction of its greater durability, and also, perhaps, a certain predilection for an ancient mode." The refinements adopted in Grecian architecture, in its purest age, to correct optical delusions (as exemplified in the Parthenon, according to Mr. Penrose's recent discoveries), come in for their share of description and approval, and we observe that the author fully coincides in the opinion that colour was from the first an essential feature of a design. "Generally speaking all those parts which, from their form or position, were in any way protected from the rain or atmospheric influences, seem to have been coloured; those particularly exposed, to have been left plain. The colour nowhere interfered with the beauty of the forms, but gave that richness and amount of ornamentation which is indispensable in all except the most colossal buildings, and a most valuable adjunct even to them." Now, without entering upon this vexed question of colour, one can hardly be brought to believe that the purest surfaces, the brightest and most polished, the most expensive and beautiful materials, were intended originally to be disguised by gaudy and irrelevant hues. Such processes, in our estimation, go far to deteriorate the genuine effect, and at least to destroy the brilliancy and sharpness of tool marks and sculpture. As Dr. Waagen forcibly remarks, when speaking of the Elgin marbles,—"I never perhaps found so great a difference between a plaster cast and the actual sculpture as in these Elgin marbles. The Pentelic marble of which they are formed, has a warm yellowish tone, and a very fine, and at the same time a clear grain, which has imparted to the sculptures a peculiar solidity and animation. The block, for instance, of which the famous horse's head consists, has absolutely a bony appearance; it gives the impression of being the petrified original horse that issued from the hand of the god."

We are rejoiced to find that Mr. Fergusson speaks boldly out for sculpture generally, as a handmaid to architecture. Explaining the Doric order, he says: "To understand it we must not regard it as a mere masonic form. Sculpture was always used, or intended to be used, with it. The metopes between the triglyphs, the pediments of the porticoes, and the acroteria or pediments on the roof, are all unmeaning or useless, unless filled or surmounted with sculptured figures. Sculpture is, indeed, as essential a part of this order as the acanthus-leaves and ornaments of the cornice are to the capitals and entablature of the Corinthian order; and without it, or without its place being supplied by painting, we are merely looking at the dead skeleton, the mere framework of the order without the flesh and flood that gave it life and purpose." If in our general eulogy of the wood-engravings interspersed throughout these volumes, we ought to make any exceptions, they would relate to those appended to this essay on the Greek orders, which are certainly coarsely outlined, and without that nice adjustment of forms which constitutes the principal charm in the details themselves.

Leaving this Classic atmosphere, we reach central Asia, halting at Diarbekr, Al Hadhr, Firouzabad, and neighbouring cities. There is no hiatus in the history of architecture more complete than that which occurs in this district for the ten centuries between the conquest of the country by Alexander the Great, and its lapsing under the yoke of the Mahometans; nor is there any gap which it would be more interesting to fill up. Two buildings only—palaces—are known to exist belonging to this period; and their details are similar to Roman work, the archivolts and pilasters almost literally so, but done so rudely as to prove that they were not executed under the eye of a Roman artist. On the ruins of the Ctesiphon of the Greeks is a palace, now only a fragment, in some respects similar to that at Firouzabad, but on a larger scale, its width being 370 feet, and its height 105, built about A.D. 550. Taking it altogether the building is interesting as containing the elements of much that followed, rather than from any intrinsic merit of its own. The same perhaps is true of the style to which it belongs. If properly

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worked out and illustrated, it would probably explain nearly all the difficulties of the Eastern forms of the Byzantine style; and there can be little doubt but that ample resources exist for the purpose, which will be available as soon as attention is fairly directed to the subject.

Under the head of "Saracenic" architecture, is described the series of mosques which afford such extraordinary material for study. With much that is noble, and among the most beautiful details, is a great deal that is ungraceful and clumsy. The author's peculiar views respecting the Holy Sepulchre at Jerusalem, are briefly touched on, but more fully stated in his work on that special subject. Many interesting buildings in the Saracenic style, in Syria, Egypt, Persia, India, Spain, and Turkey, are quoted in our "Handbook," and accompanied by abundant illustrations. Among these, the curious pendentive from a mosque at Old Delhi (p. 428) will attract attention. These pendentives, it seems, are remarkable for the elaborateness of detail. Their forms are so various that it is impossible to classify or describe them. (In the one engraved, the angle is filled up with a number of small imitations of arches, bracketing one beyond the other:—it was this form that was afterwards converted into the honeycomb work of the Arabs in Spain). The Moorish method of doming or vaulting, too, furnishes an interesting chapter, and the description of the Alhambra will be read with pleasure.

Thus Saracenic architecture presents a boundless multiplicity of detail, and "innumerable hints for those who know that art is not confined to one or two forms, and is not to be confined by figures or by rules, but is everywhere and in everything for those who seek it honestly and for its own sake."

On approaching the subject of Christian architecture, which is subdivided into several distinct heads, the author naturally adverts to the varied nomenclature which it has received, and expounds his own opinions at some length. The following are among the observations:—

"Before proceeding to describe any of these styles, it is necessary to say a few words on the nomenclature to be adopted; not that there is really any difficulty in the subject, but that, as always happens in young sciences, considerable confusion has been introduced by hasty generalisation and ill-judged attempts to apply a system of names suited to preconceived ideas, instead of merely affixing such names as serve best to describe the objects spoken of.

In speaking for instance of the styles that have already occupied our attention, it has been sufficient to specify Egyptian, Assyrian, Persian, or Grecian and Roman architecture; subdividing these, when necessary, either by mentioning the age of the variety we wish to particularise, or applying it to some dynastic or epochal name in order to fix its age. Thus the varieties of Egyptian architecture are identified by describing them as the styles of the fourth or of the eighteenth dynasty, or of the Ptolemys or Romans. These varieties too may be farther marked by the names of kings to any extent required. The Ages of Pericles and Alexander were the two great epochs of Grecian art, and names either before or after these may be taken to fix the age and style of any work with the utmost precision. So in Rome, the names of Augustus, Nero, or Trajan; of the Antonines, of Caracalla, or of Constantine, subdivide their art without confusion or mistake, and without the necessity of any system. But after this age these wise and simple principles of nomenclature have been abandoned. It has become, for instance, the fashion to apply the term Byzantine to styles as unlike anything Byzantium ever saw as any one style can be to another, and where it is impossible to trace any influence, direct or indirect, that capital had on the buildings in question. Romanesque in like manner is applied to styles as essentially Barbarian as the most pointed and most florid Gothic. It has been attempted to apply the name Lombard to all the round arched styles of Europe, and German and Teutonic to all the pointed arched styles, all involving the assumption of theories which, so far from being granted, are generally without the least foundation in fact.

In this country, this predilection for the systematizing of styles has been pursued with more assiduity than elsewhere, and one nomenclature has succeeded another with a rapidity that has rendered confusion worse confounded.

One of the earliest and best attempts was that of Rickman; he divided our native art into four divisions: Norman, Early English or Lancet, Decorated, and Perpendicular. From the last it has been found requisite to separate the Tudor, as a well-defined variety; and the acknowledgment of Saxon has, again, entitled that style to rank with the rest. We have here, therefore, three or four dynastic names, and as many technical ones. Latterly several attempts have been made to improve on this, but generally by getting rid of the dynastic names and substituting for them technical ones—derived either from the window tracery, or some subordinate peculiarity which the names assigned always describe briefly, often incorrectly, and after all convey no information. The terms Saxon, Norman, Tudor, Elizabethan, and such like, however, maintain their ground, and I believe a far more philosophical course would be to extend these, leaving the technical names merely as descriptive affixes. Thus, English architecture might be divided into Saxon, Norman, Plantagenet, Edwardian, Lancastrian, Tudor, and Elizabethan. Jacobean has been applied to the next variety, while that which follows, including the works of Inigo Jones and Wren, might be appropriately distinguished by the name of Stuart. Denominations of this sort admit of subdivisions to any extent. Thus the styles of the 1st, 2nd, or 3rd Edwards are sufficiently distinct to require separate names, though no technical term could point out exactly in what the difference consists. Even the styles of the beginning and end of the long reign of Edward III. require to be distinguished, and can easily be by this form of nomenclature, but can by no other yet proposed. So with the four Georges or the Stuarts, Lancastrian, Plantaganet, &c. The three Richards, by a singular coincidence, mark three ages of transition. Even without these adventitious advantages, a name so given marks the country and the age without fail, and describes the style with perfect correctness, without even suggesting the necessity of a system.

Another mode of attaining the same end has been partially adopted by the French, by giving the date instead of the dynasty: thus they speak of their styles of the 12th, 13th, or 14th centuries, and subdivide them into styles of the 'first half,' 'second half,' or commencement or middle of each of the centuries; a process as unobjectionable as the one above described, except in the circumlocution it requires, and the desirability of finding a single word if possible to express our meaning.

Whichever of these two last systems it may be thought most expedient to adopt, the great desideratum is obtained of a title which shall in the first place express the country where the style was practised and is found, and secondly the age to which it belongs. A third or technical title may be added to characterise it, but this is always unnecessary to any one at all acquainted with the subject; for when the country and age are known, the style is far more clearly suggested than it could be by any technical term drawn from one of its peculiarities.

It has been objected to the name of Gothic that it was first used as a term of reproach, and is still often so used in common parlance; but it is never now so applied to architecture—it is therefore needless to regard this. Another and more important objection is that, though the Goths were one of the first invading tribes, they were insignificant in extent, and disappeared from the scene before the style attained anything like perfection. This would be fatal were we inventing a totally new system of nomenclature; but the term being in general use, and sufficiently expressing what we desire to express, it is better to take it than to supply an entirely new name. We would be understood therefore to apply architecturally the term Goth to all those Teutonic tribes of barbarians who overwhelmed the Roman empire, and in the dark ages established themselves within its boundaries. So defined, it will be found that, exactly in the ratio in which this barbarian element prevailed, the style of which we are speaking flourished in originality and beauty; but also that no other term or national name will comprehend all those various tribes and races who then occupied Europe.

If it were desirable to establish a new name in lieu of Gothic, by far the best with which I am acquainted would be Feudal architecture, as the style of which we are speaking arose with feudality, attained perfection with that system, and declined and expired with it. Moreover it existed in all those countries where the feudal system was introduced, and is found existing in those only, so that no name could be more appropriate or more correctly descriptive. The one apparent objection is that nine-tenths of the buildings we now find are ecclesiastical, and we generally apply this name only to secular institutions. The Church, however, in the middle ages was as essentially a part of the feudal system as the state itself, and bishops, abbots, and the lower grades of clergy, were as essentially peers and fiefholders as the barons with whom they were associated."

Not less important are the historic distinctions and traits of Gothic architecture in Europe. Lombardy takes the first place, as the spot earliest civilised, and where the arts first attained any degree of consistency or perfection. Next, the German or Rhenish style; and, cotemporary with these, the Round-arched Gothic styles of France. These, though exceedingly and perplexingly various, never became so important as the Lombard or Rhenish, though in many instances displaying a vast amount of interest and elegance.

There can now be no doubt but that the Pointed style was invented in France, and brought to a great degree of perfection there before the neighbouring countries took it up.

"After this it is easy to trace its introduction from France into Germany, and to point out the various modifications it underwent in that country. Few of these can be called improvements, though, from their being generally of the best age, and when architecture was almost suspended in France from the troubles of the country, the accidental result is that Germany possesses some Gothic buildings that may fairly rival many in France.

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Again, the introduction of this style from France and Germany into Italy is easily traced and understood, and the various modifications it underwent there—none of which were improvements—are only too easily pointed out.

Another chapter will include Spain and Portugal, where again we have an even stronger admixture of Saracenic art, giving to the Gothic of Spain a peculiar individuality of character which distinguishes it most essentially from those enumerated above.

From this we pass to Great Britain, where the history of the art is very similar to that of France; but at the same time exhibiting peculiarities well deserving of attention, and more interesting to us from their locality than almost any of those above pointed out.

Our enumeration concludes with Scandinavia, a country regarding which very little is yet known in an architectural point of view, though its Round Gothic buildings are both numerous and interesting. In the Pointed style it has few buildings of importance, and these are so distinctly copies from the French, that little need be said about them."

In the Romanesque style, progressive development is traced through the "basilica," with its adjoining round church or baptistry (which also enshrined the tombs of important persons), and the different features of the apse or choir; and a list is given of about thirty of these churches in Rome, extending in date from the 4th to the 14th century. One of the most pleasing features in these churches are the mosaic pavements that adorn the greater number. They were always original, being designed for the buildings in which they are used, and following the arrangement of the architecture that stands on them, while in patterns and colour they are notably advantageous to the general effect. Pisa cathedral is given as a specimen of exterior colouring "as an elegant and pleasing mosaic," and as a proof that in the age of its erection "colour was a more common external decoration than form." All the Roman basilicas were enriched—on their façades at least—with historical paintings or mosaics of figures and emblems on flat surfaces. In contradistinction to the Roman basilicas, we have a careful description of the exteriors of ancient Lombard churches, as follows:—

"Generally speaking, the most beautiful part of these Lombard churches is their eastern ends. The apse with its gallery, the transepts, and above all the dome that almost invariably surmounts their intersection with the choir, constitute a group which always has a pleasing effect, and very often is highly artistic and beautiful. The sides, too, of the nave are often well designed and appropriate; but, with scarcely a single exception, the west end, or entrance front, is comparatively mean. The building seems to be cut off at a certain length without any appropriate finish, or anything to balance the bold projections towards the east. The French cathedrals, on the contrary, while they entirely escape this defect by means of their bold western towers, are generally deficient in the eastern parts, and almost always want the central dome or tower. The English Gothic architects alone understood the proper combination of the three parts. The Italians, when they introduced a tower, almost always used it as a detached object, and not as a part of the design of the church. In consequence of this the façades of their churches are frequently the least happy parts of the composition, notwithstanding the pains and amount of ornament lavished upon them.

Instead of recessing their doors, as was the practice on this side of the Alps, the Italians added projecting porches, often of considerable depth, and supported by two or more slight columns generally resting on the backs of symbolical animals. No part of these porches, as an architectural arrangement, can be deemed worthy of any commendation; for in the first place, a column planted on an animal's back is an anomaly and an absurdity, and the extreme tenuity of the pillars, as compared with the mass they support, is so glaring that even its universality fails in reconciling the eye to the disproportion. Above there is generally a gallery, sometimes only in the centre; sometimes at the sides, though often carried quite across; and in the centre above this there is almost invariably a circular window, the tracery of which is frequently not only elaborately but beautifully ornamented with foliage and various sculptural devices."

Then the Campaniles which so distinguish Lombardy, are thus described:—

"There is no architectural feature which the Gothic architects can so justly call their own as the towers and spires which in the middle ages were not only so favourite, but so indispensable a part of their churches and other edifices, becoming in fact as necessary parts of the design externally, as the vaults were of the internal decoration of the building.

It is true that we neither know where they were first invented, nor even where they were first used as applied to Christian churches—those of Rome or Ravenna being evidently not the earliest examples; and what is still more unfortunate, they have no features which betray their origin, at least none have yet been pointed out, though it is by no means impossible that a closer examination would bring some such to light. They certainly are as little classical, both in their forms and details, as anything can well be conceived to be; nor can the very name of Romanesque be considered entirely appropriate, though we are compelled to use it as marking the age and locality in which they occur.

The tower of St. Mark at Venice, for instance, and the Torraccio at Cremona, are evidently civic monuments, like the belfries of the Low Countries—symbols of communal power wholly distinct from the church, their juxta-position to which seems only to be owing to all the principal buildings being grouped together. This is certainly the case with a very large class of very ugly buildings in Italy, such as those attached to the town-halls of Florence and Sienna, or the famous Assinelli and Garisenda towers at Bologna. These are merely tall square brick towers, with a machicolated balcony at the top, but possessing no more architectural design than the chimney of a cotton factory. Originally, when lower, they may have been towers of defence, but afterwards became mere symbols of power.

There is a third class, and by far the most numerous, which are undoubtedly ecclesiastical erections; they are either actually attached to the churches, or so placed with regard to them as to leave no doubt on the matter. There is not, however, I believe, in all Italy, a single example of a tower or towers used, as on this side of the Alps, as integral parts of the design."

A separate chapter is allotted to "Swiss" architecture, usually too much overlooked by tourists in their admiration of the natural beauties of the country. Nevertheless, as Mr. Fergusson shows, it partakes largely of the genuine elements, and contributes not a little to the picturesque harmony of the scenery. The cathedral of Zurich furnishes materials for some curious engravings.

Passing over the treatises on Rhenish architecture, and early German characteristics, which have of late been so fully exemplified, we come to a valuable chapter on French art, as exhibited in its several provinces of Provence, Aquitania, Anjou, Auvergne, Frankia, Normandy, Burgundy, and others. Perhaps this section of the work is the most completely treated of any, and as it points out minutely those individual details of expression which each locality presents, it will be found to offer a variety of sound and suggestive information. After a short notice of Belgian architecture, and the magnificent Halls at Ypres, Louvain, and Brussels, the subject of German development is again resumed. This people, it is shown, borrowed their pointed style from the French at a period when it had attained its highest degree of perfection in the latter country; and then, after a brief reference to transitional stages, the glorious example at Cologne is characterised as the great typical cathedral of Germany, and one of the noblest temples ever erected by man in honour of his Creator. Besides its great size, this cathedral has the advantage of having been designed at exactly the best age; those of Rheims and Paris being a little too early, and that of St. Ouen too late. Still, Cologne has its blemishes, particularly in its redundance of enrichment, and the forest of exaggerated pinnacles which crowd the upper part of the building. Decorated construction is, no doubt, the great secret of true architecture; but, like other good things, this may be overdone. Friburg, Strasburg, and Ratisbon, next come under consideration, and then St. Stephen's at Vienna, which ranks fourth or fifth among the great German churches, both for size and richness of decoration,

The Civil architecture of Germany is spoken of in but qualified terms. The only really important palace (date 1309) is the Schloss Marienburg, in Prussia, which is in truth "one of the worst specimens of this class of buildings, and as bad a piece of architecture as Germany possesses." The feudal castles, again, have little to recommend them. "The same remarks apply to the domestic residences. Many of the old gabled houses in the streets are most elaborately ornamented, and produce picturesque combinations in themselves and with one another; but as works of art, few have any claim to notice, and neither in form nor detail are they worthy of admiration. Nuremburg is, however, in some respects an exception."

Italy.—The history of the Pointed style in Italy appears to be "less instructive than that of the same art in Germany."

"Its importance consists in the evidence, imprinted on the buildings of the country, of the extent to which the influence of the Northern races with their feudal system was felt here, of the duration of that influence, and the degree in which it was modified by the Italian element which lay beneath. All this can be read at a glance in the architecture of the age, and nowhere is it depicted with the same clearness and fixed so unalterably and indelibly as it is in Italy.

To the mere student of architecture, too, it is interesting to trace at what points it failed to equal the contemporary styles on this side of the Alps, and from what causes, thus revealing to us the secrets of the success of the French architects, which, without this test, it might be difficult to detect. In Italy we find buildings scarcely surpassed in size

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by any others in Europe. The best possible construction is combined with the most beautiful material. The vaulted roofs are of the most daring construction, supported by coupled piers; and the pointed arch, on which so much stress is usually laid, is used currently in every part, and yet with all this, these buildings are only cold, unmeaning, inartistic productions, with all the defects and hardly one of the beauties of the true pointed Gothic edifices. This being so, it cannot be difficult to find out to what the one style owes its perfection, and what was the cause of want of success in the other.

One great cause of this seems to lie deep in the character of the people. It is to be observed that, however excellent in other departments of art, no Italians were ever great architects. The Etruscans, as we have seen, were not extensive builders, though what they did they seem to have done well. The Romans borrowed a style from the Greeks, which they never understood, and which they misused, misapplied, and spoilt. The Lombards were Germanic foreigners in the land, and great and original as builders only so long as they retained their nationality. No sooner did their distinct character die out and the indigenous race resume its sway, than their architecture decayed; they adopted the then fashionable style of France and Germany, but adopted it too late, without comprehending its principles. Dissatisfied with their own productions, the Italians quickly abandoned it, and returned to the old classical style. This last change seems to have been made far more from associations with the name of Rome, which alone rendered them and their peninsula illustrious, than from any distinct perception either of the beauty of the style itself or of its fitness for their purposes. Unfortunately for Europe, the revival of classical literature at the same time led the Northern nations to follow the same vicious path, and to cover the land with all the absurdities of the revived classical school."

Among the edifices described is Giotto's Tower at Florence, which is designated "a very beautiful building, though hardly worthy of the praise that has been lavished on it." One great defect of the composition is its straightness, its height requiring a greater expansion at the base. Another fault is the strongly-marked horizontal courses, dividing the height into distinct stories; and a third is, the false character of the ornamentation, which chiefly consists of a veneer of party-coloured slabs of marble, which, however beautiful in itself, is objectionable, as not forming a part of the apparent construction. This is the pith of the author's criticism, and it appears to be just.

We shall be pardoned for not amplifying our remarks on Italian architecture, having so lately (October, 1855) discussed the subject fully, when reviewing Mr. Street's volume on 'Ornamental Brickwork of the Middle Ages,' a book from which Mr. Fergusson has borowed some of the choicest illustrations.

With Italian architecture is intimately connected that of Sicily, so interesting as clearly elucidating the history of the pointed arch there, and its peculiar development. All the churches of Palermo supply abundant features for study, as also does the quaint cathedral of Cefalu, founded by King Roger in 1131.

Spain and Portugal.—The monuments of Gothic architecture in Spain are known to be numerous and splendid, and its history would be of surpassing interest, but beyond this the subject is almost unknown. Till some accurate plans of Spanish churches are published, it is impossible to understand either what their general arrangements are, or whence derived. It may, however, be inferred, that all the older and smaller churches possess the usual semicircular apse, while the cathedrals and larger churches display the *chevet* arrangement. These larger churches have transepts also, and a dome or low tower at the main intersection; the arrangement being probably derived from the Roman basilicas. Among the woodcut illustrations are exquisite ones of the cathedral at Toledo and a cloister near Burgos.

From the extent to which this article has reached, we are compelled to skip much of the interesting matter which we find collected, relative to the history of the Pointed style in England; but, as is stated at the outset, "it has of late years occupied the attention of so many competent persons, and been written so fully and in such a variety of forms, that little that is new remains to be said on the subject."

"As in all other countries of Europe, the style may be naturally divided into two great branches, the round arched and the pointed arched. The former as easily subdivides itself into the Saxon and the Norman; the latter, as before pointed out (p. 475), may conveniently be divided into Plantagenet, Edwardian, Lancastrian, and Tudor; the periods of transition between each of these falling by a curious coincidence in the reigns of the three Richards. These divisions are, it is true, somewhat indefinite, but they are necessarily so, as the changes were frequently slow, and began, and were nearly perfected, in one part of the country or in one building, before they were thought of elsewhere; and in no place were they suddenly introduced so as to enable us to fix the exact year or mode of their introduction. The fact is, that it was a constant prorgession from a rude to a highly finished and elegant style; the improvements taking place steadily from year to year up to a certain point, and then declining as steadily to the Elizabethan period, without any resting-place being found in the whole series, so that all attempts at a more rigid classification only lead to false impressions or to error, and the sooner they are abandoned the better."

The "Perpendicular" style the author views more favourably than some other modern writers; its misfortune being, he says, that it fell on evil days. "Used as it was at first, or as it might in a better age have become, it may be considered as showing nearly the perfection of tracery. It possessed, however, within itself a fatal facility which brought down the art to the meanest capacity, and afforded no scope or exercise for the highest intellects. The tendency of the age was for the greatest possible effect at the least possible expense; hence the perpendicular tracery soon became prosaic to the last degree, and utterly unworthy either of its predecessors or of its own capabilities."

In illustration of mediæval English architecture, the cathedrals of Canterbury, Rochester, Chichester, Salisbury, York, Lincoln, Norwich, and Ely, also the abbey at Westminster, St. Stephen's Chapel, Westminster Hall, Eltham, and Windsor, are each described and compared, and the subject is closed by some observations on the peculiarities of English Gothic, especially with reference to its vaulting. A subsequent chapter treats of Scottish architecture, for which the author has drawn largely on Mr. Billings' well known work, and re-engraved very many of his illustrations. A short essay on architectural remains in Ireland is appended. In conclusion, we are directed to Byzantine art, in a valuable chapter nicely discriminating between the influences of the civil and religious elements in its design. For the reason above stated, we are precluded from making quotations, but it is throughout ably written, and goes far to clear up several of what are generally considered debateable points. It is these historic notices which throughout the "Handbook" constitute its distinctive and most valuable feature, in which the chief drawback is that the opinions put forth (not unfrequently in direct challenge with other authorities) are expressed in rather a too dogmatising a tone. The author, however, speaks evidently from his own convictions, and thus may in some measure be excused; while it will be acknowledged by all that his book, taken as a whole, is one of the best and most likely to serve its object which the age has produced.

Catalogue of a Collection of Works of Decorative Art; being a selection from the Museum at Marlborough House. By J. C. Robinson, F.S.A., Curator.

Ditto, ditto, on Ornamental Art. London: Eyre and Spottiswoode. 1856.

These are two very useful works, issuing from the government press, containing much of interest to the antiquary as well as to the decorator. They describe, in very clear and concise terms, the many beautiful works collected at Marlborough House, after the Great Exhibition of 1851, and now used for educational purposes.

One of the catalogues, on 'Ornamental Art,' contains some well executed wood-cuts, and we cannot understand why the "Decorative" catalogue should not also be illustrated; indeed, we are at a loss to see where the line can be drawn between "Ornamental Art" and "Decorative Art." The former, the illustrated one, contains specimens of sculpture, glyptic and numismatic art, mosaics, general upholstery, glass painting, and other works. While the latter, without illustrations, gives descriptions only, of works in metal, coins and medals, stoneware, porcelain, enamels, leather-work, drawings, &c. Among the engravings are a very finely executed wood-cut of the "Inside of Lid of a Wooden Box, inlaid with ivory marquetrie. German; dated 1566. Length 12 inches, width 7½ inches." A neat outlined drawing of an "Arm-Chair in carved oak. Italian; date about 1000. Height 3 ft. 9 in., width 2 ft. 6 in." Another of a "Wine Flask in embossed leather-work. Italian; circa 1540." There are also several neat outlines of glass manufactures, carvings in wood, &c.

We are very grateful for anything that government will do towards education in the arts and sciences, and therefore hail with pleasure these little advances towards so great an object, The creditable way in which the works are got up, and the remarkably low price—viz. 4*d.* for the catalogue on Decorative Art, and 6*d.* for the illustrated one on Ornamental Art—show an earnestness on the part of the authorities to do something at last for the service of the arts.

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SIR CHARLES BARRY AND THE TREASURY.

Copies of Treasury minute, dated the 6th February, 1854, and 29th January, 1856, have been issued, with regard to the claims of Sir Charles Barry for services connected with the building of the New Palace at Westminster. This sets forth that on the 26th May last the following offer was made to Mr. White, as acting for Sir C. Barry, with a view finally to settle all questions as to commission, measurement, and all other claims up to October 2nd, 1853, to which date the closed accounts extended, Sir C. Barry, it should be said, having put in various claims for extra payment over and above his commission:—

"That a commission of three per cent. should be allowed on the entire outlay of 1,506,845*l.* up to the 2nd October, 1853.

2. That a remuneration for measurement upon the whole of the works included in that outlay should be paid at the rate of one per cent.

3. That those commissions should cover all demands of every kind whatsoever for the past, the services for warming, lighting, and ventilating alone excepted, which should be dealt with separately, and upon their own merits.

4. That the remuneration of Sir Charles Barry for the future should be fixed at—

Three per cent. commission on the outlay as architect, and one per cent. for measurement upon all works to which measurement applies; and that no furniture, &c. should in future be furnished by Sir. C. Barry, except by the special order of the Treasury.

After numerous further interviews and discussions with Mr. White, that gentleman, on the part of Sir Charles Barry, declined the terms of settlement thus offered, and pressed again the claims for the extra services performed.

My Lords having again referred Sir C. Barry's claims for a report to the Board of Works, and having very carefully reviewed the whole case, continue to be of opinion that the terms herein stated are not only fair but liberal; that they include all remuneration to which Sir C. Barry is justly entitled for the services he has performed; and that they could not extend the same consistently with their duty to the public.

Considering, moreover, that the matter has gone on for nearly twenty years without any distinct understanding being arrived at, notwithstanding the efforts of every successive Board of Treasury to do so, my Lords are of opinion that it is inconsistent with the public interests that it should be any longer delayed, and they therefore, as far as they are concerned, must record these terms as their final decision upon the questions at issue. They are pleased, consequently, to direct that no further payment be made on account until a final settlement of the past, and an agreement as to the future, are concluded."

The following statement, in reply, has since been put forth by Sir Charles Barry:—

Previous to Sir Charles Barry's appointment in the year 1837, the estimate for the then proposed building was reported to Paliament, with an allowance attached to it, by the Board of Works, of the usual commission for the architect of five per cent.: and he entered upon his duties upon the understanding that such should be the amount of his remuneration. After an exercise of those duties for more than eighteen months, he was informed of an order from the Treasury, that for certain reasons assigned, his remuneration was to be limited to a fixed sum of 25,000*l.*, being nearly 10,000*l.* short of his stipulated commission, and that the same principal of limitation was to be applied to all public buildings from that time. Against this decision Sir Charles entered a protest, which has never been answered or contested; nevertheless, by the advice of his friends, he acquiesced in the decision, upon condition that it should be reconsidered on the completion of a considerable portion of the work, when he expressed his belief that the injustice of such a reduction from his legitimate claims would be manifest.

Owing to a considerable extension of the building, numerous changes in its design and internal arrangements, which have not only been sanctioned but commended by parliamentary committees of enquiry, unlooked-for difficulties in the progress of the work, particularly as to the foundations in the river, great increase in the value of materials and labour, and other causes beyond his control, the amount of expenditure incurred, and the time for executing the works, have been greatly increased, by which the reasons assigned for the reduction of the architect's remuneration have been falsified, and not one of the conditions of that reduction has been fulfilled. The government has in effect admitted the nullity of that arrangement by making unconditional payments to the architect, from time to time, of about 20,000*l.* beyond the original fixed sum. After much negociation with many successive governments for nearly twenty years, the present one has made an offer of four per cent. upon outlay, and a special recompense for the trouble and difficulties encountered by the architect in respect of the warming, ventilating, and lighting arrangements of the building. With respect to the appointment of the late Mr. Pugin, and to a claim made by their Lordships for a set-off upon the architect's commision on account of moneys paid to him, Sir Charles pointed out that Mr. Pugin was not employed upon any duties that devolved upon the architect of the new palace, inasmuch as all designs for that building had emanated from Sir Charles himself; but only as the superintendent of the wood-carving department, in carrying out the architect's designs, to which office he was appointed by the government at a salary.

In conclusion, Sir C. Barry says:—"Sir Charles conceives that he has a right to complain that the Lords Commissioners of her Majesty's Treasury have constituted themselves the judges in their own case; that they have formed their decision partly upon *ex parte* statements, to which he is an entire stranger; that, while they are now paying at the least five per cent. to all architects and engineers of independent practice for works of the plainest and most simple, although most expensive, character, they make the new palace at Westminster, which undoubtedly is the most elaborate and complicated edifice in modern times in this country, the sole exception, and propose not only to pay to its architect nearly 20,000*l.* less than his legitimate claims, but to deprive him of all remuneration whatever for many extra services not pertaining to his duties as the architect of the new palace; and to which their offer of commission can have no reference; and, lastly, that their lordships have not acceded to a reference of the several questions at issue, although Sir Charles has repeatedly expressed his perfect readiness to abide by the verdict of such a tribunal."

IMPROVEMENTS IN HANGING CLOCK-TOWER, TURRET, AND OTHER BELLS.

W. Lewis Baker, C.E., 25, Parliament-street, *Patentee.*

There are three principal features in Mr. Baker's improvements—First, a circular boss is cast on the crown of a bell, through which a single bolt of sufficient strength is passed, and attaches the bell to the stock. Secondly, metal is used instead of wood for the stock and other parts. Thirdly, the bell is attached in such a manner to the stock (whether by a single central bolt, as above described, or by casting an axis on the top of the crown, or any similar contrivance), that the bell may be turned round its vertical axis, and present in succession a fresh part of the bell to the blows of the clapper. To facilitate the turning of heavy bells, a screw or pinion and toothed-wheel is connected with the boss.

The following description of the leading details of these improvements will be understood on reference to the accompanying engravings.

Instead of the ordinary ears, technically called canons, a strong circular boss Q, concentric with the remainder of the bell, is cast on the crown B B. A single bolt A, with nuts H, H, at the upper end, firmly secures the bell to the stock G; this bolt is passed up through the centre of the boss Q, and the stock G, till the collar C, forged on the bolt comes in contact with the underside of the bell: the nuts H, H, are then screwed down upon the top of the stock, and the top of the boss Q, brought thereby into firm contact with the stock, to which the bell is thus securely fixed. The lower end of the bolt A, is prolonged and formed into a joint D, to carry the upper end of the shank E, of the clapper F.

The stock G, is cast in iron, having a central boss to receive the main bolt A, and the bell's boss Q. The two gudgeons O, O, are securely fixed in the ends of the stock, and turned accurately true with one another. The stock receives the rigger-wheel X, on one of its ends, and the catch T on the other. A socket U, is cast in the stock to receive the lower end of the wooden stay V. When the bell is set, that is, in a state of rest with the mouth upwards, the upper end of the stay V, rests against the tail W, of the catch T, which itself rests against a stop on the frame. The rigger-wheel X, is attached to the upper part of the stock by a bolt Y,

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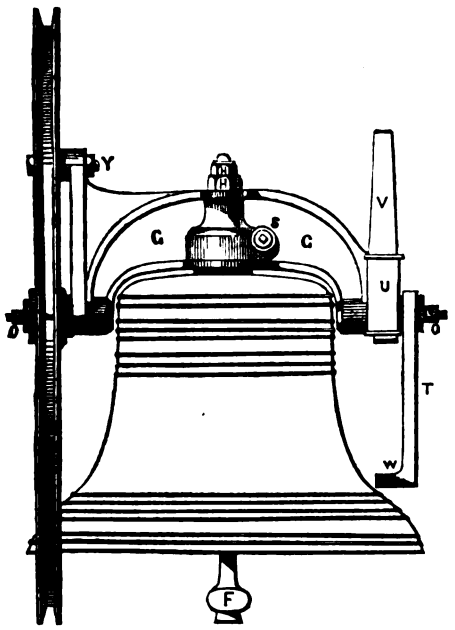
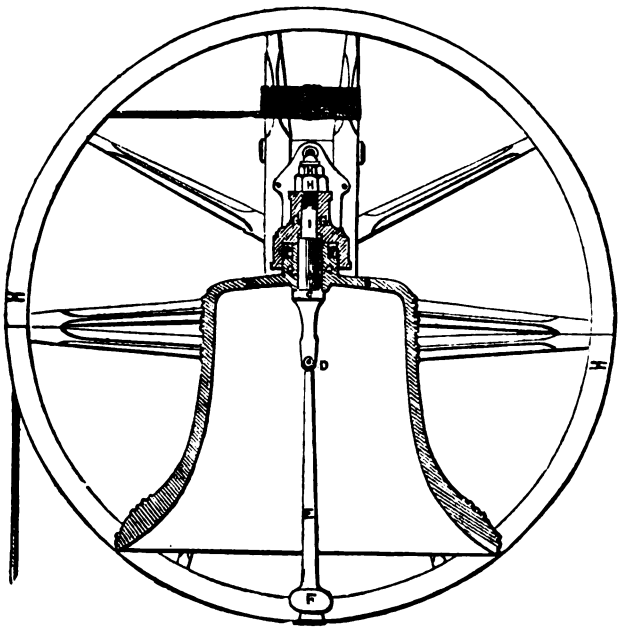
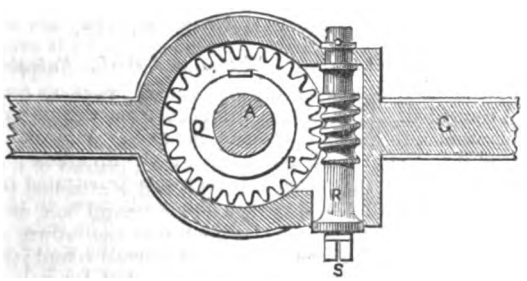




Lastly, an endless screw R, is fixed in the stock, and made to gear into a toothed-wheel P, which is keyed on to the central boss Q, of the bell. The outer end S, of the endless screw's spindle may be turned by hand with a spanner or wrench, and through the medium of the toothed-wheel move the bell round horizontally. The main bolt A, is prevented from turning with the bell by being made square at the part I, in order that the joint D, of the clapper may always remain in the same plane with the gudgeons.



Some further details will be found in the published specification of the patent (1854, No. 841), and in a Paper by Mr. Baker, read at the Royal Institute of British Architects, March 5, 1855, which contains also an explanation of the "principal features and details of the *ordinary* system of bell machinery, the uses of its various parts, and the manner in which a bell is rung."

A single bolt is manifestly sufficient to fix a bell securely to the stock, provided it be of the dimensions necessary to resist all the strains incident to its use. One main bolt also renders this part of bell-hanging more simple and inexpensive than the introduction of a number of bolts for the same purpose, besides possessing the further advantage of enabling the bell to be easily moved round in order to spread the wear occasioned by the clapper equally round the sound-bow. A bell cast on this plan, with a central boss or axis, becomes a solid of revolution, and on that account is more perfect, and will give a purer quality of sound than the ordinary bell, the canons of which form irregular projections on its crown. Ordinary bells are frequently found to have their crowns cracked by the oxidation of the piece of iron cast in for the purpose of suspending the clapper; this risk is obviated by Mr. Baker's system.

Owing to atmospheric changes it is impossible that the wooden stocks now in general use should remain permanently true; their form becomes more or less distorted, and their gudgeons out of line: increased friction is the consequence, giving unnecessary labour and discomfort to the ringers. These defects are completely remedied by the use of iron stocks, which are practically unaffected by atmospheric changes, are much more rigid than wooden ones, and their wrought-iron gudgeons being fixed and turned truly with one another, always remain true. The further addition of iron framing, which has been suggested by Mr. Baker, would render bells fire-proof. But the greatest defect attending bells hung in the ordinary way is, that they always become more or less injured, and frequently cracked, by the blows of the clapper. These blows, continually repeated at two points only of the sound-bow, cause indentations of considerable depth, and ultimately destroy the bell. Mr. Baker's simple and inexpensive contrivance for spreading this wear all round the bell, is, therefore, a very satisfactory part of his improvements.

Bells are general public favourites. We therefore feel much pleasure in calling attention to improvements in them and their gear, which are simple in principle and well considered in detail. This mode of hanging bells will render them more durable, diminish the labour of ringing, and to some extent improve the quality of their sound. The tone of the 5 cwt. bell, cast by Messrs. Mears, of Whitechapel, which was exhibited by Mr. Baker at Paris last year, was considered remarkably good. We nd erstand that this bell will be hung in a church now in course of erection.

We have the satisfaction of stating that a prize medal was awarded to Mr. Baker, at the Paris Universal Exhibition, for these patent improvements.

LOCOMOTIVE AND OTHER STEAM BOILER FURNACES.

Thomas Russell Crampton, Adelphi, *Patentee*, March 31, 1855.

This invention has for its object a peculiar combination of the parts of the furnaces used for locomotive and other steam-boilers; and the invention consists of employing a series of flat bars, arranged transversely, of a furnace of a steam-boiler, one bar below another, and somewhat forward of each other, thus producing a shelving grating, with spaces for the passage of air horizontally between the bars; and at the lower part of such series of shelving bars is a series of ordinary fire bars, which receive the well ignited fuel descending down the shelving bars, such grating of ordinary fire-bars being arranged to move on axes, to allow of the dropping of any fire thereon when desired; this arrangement of the parts of a furnace rendering the use of a blast unnecessary, at the same time the fuel will be more advantageously burned, particularly when coal is employed, as the same may be consumed without evolving smoke. The shelving bars may be made fixed or moveable.

Claim.—The mode of constructing or arranging locomotive and other steam-boiler furnaces described, with means of voiding the lower parts of the fire when required, and so as not to require artificial blast.

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SEWERAGE, DRAINAGE, AND WATER SUPPLY OF SOUTHPORT, LANCASTER.

By Robert Rawlinson, C.E., Superintending Inspector.

(*Abstract of Report to the Board of Health*).

Southport is situated upon a sandy subsoil at the estuary of the river Ribble. The main street is parallel with the beach. The present town has grown up within the memory of persons now living. A few years since the district was a waste of sand hill, scarcely known but to the solitary inhabitants farming the land, the roads were bad and the traffic small; now a town, having spacious streets, public establishments, and many large detached houses exists,—there are good roads and railway communication from Liverpool, Manchester, and the thickly populated district of Lancashire. Proper local management may make Southport one of the most important and prosperous sea-bathing towns in the north of England. The district is on new red sandstone, the subsoil being sea-sand; large areas of moss exist in the vicinity. The sea shore is very flat, and as tides rise from 20 to 30 feet vertical, there is a large area within tidal influence, high water bounding the town and terrace walls, low water receding upwards of a mile. This renders town drainage seawards difficult, and, if improperly executed, dangerous.

The climate is mild, and the subsoil peculiarly dry. That is, rain is absorbed at once, leaving a tolerably clear surface. This absorbent power of the subsoil is one of the attractions to visitors, and, under existing conditions, a bane to residents; cesspools are formed near dwelling-houses into which liquid and soil refuse is passed, to be absorbed, and many house are supplied with water drawn from wells sunk in this sand. Contamination has taken place to a serious extent, and the evil will spread unless proper sewers and drains are constructed to remove the refuse. Waterworks are being formed at a distance for the supply of the town and district, so that local pumps and wells may be abandoned.

Local Government and Local Acts.—The town is governed by commissioners appointed under the powers of a Local Act (9th Vict. sess. 1846). A waterworks Act was also obtained (17 and 18 Vict. sess. 1854).

Population, Houses, &c.—The town of Southport comprises a portion of the township of North Meols, in the parish of the same name. The following is the extent and population of the township of North Meols in 1851:—Houses inhabited, 1595; uninhabited, 44; building, 19; total, 1658. Population in 1851, 8694. The increase of population since 1821 (2763) is ascribed to the resort of visitors to Southport as a watering place.

Before the last census (1851) the population of the town of Southport was not distinguished from that of the township of North Meols. In that year it was as follows:—Houses inhabited, 878; uninhabited, 31; building, 19; total, 928. Population, 4766.

Gasworks.—A sum of 5562*l.* 5*s.* 7*d.* has been spent on gasworks. The revenue of the commissioners from the sale of gas is increasing. The works yield a considerable profit.

Analysis of the Improvement Act.—The improvement Act passed in the session 1846, contains 357 clauses. In the Act powers are taken for nearly all the purposes required for the management and government of a town. In the evidence attention was called to defects in the Act; it will be for the advantage of the ratepayers if these are amended. The Act contains most important provisions, and if carried into effect will be beneficial to the town.

Mr. Richard Barrow stated,—"That he was surveyor to the improvement commissioners. He had held the office seven years. He received a salary of 18*s.* per week, and he devoted his whole time to the duties. His travelling expenses were paid. The commissioners published accounts annually. He had laid down the whole of the sewers. The outfall was at the bottom of Neville-street and on to the shore. It goes to high water. It finds its way into the sand and down the shore. He had not had occasion to examine many of the sewers on account of stoppages; but only to see if anything was lodged in them. The sewers do not carry away the contents of the waterclosets. The refuse from waterclosets and privies is carried into cesspools. The sewers in fact are merely drains to carry off surface water, just intended to take away the refuse from waterclosets. He had at times a difficulty in getting a proper fall. The least fall was one and a quarter in twenty yards. Complaints have been made as to sewerage, and applications made as to waterclosets. The parties who live in the streets not sewered contribute towards those sewered. The commissioners have never instructed him to lay out an entire system of sewerage for the town. Mr. Newlands, the engineer to the corporation of Liverpool, was instructed to suggest a plan, and he made a report thereon. He had not made himself acquainted with the principle of sewerage as practised in other towns. He had been round to other towns where sewerage is going on to see the working of it. He had been to Liverpool, Wigan, Ormskirk, Preston, and other places. He had experience at Tarleton for many years as assistant to his father. He then came as surveyor to the commissioners, and was afterwards appointed to overlook the market. There was no regular system of sewerage, but the drains were made as occasion might require. All had been done by order of the Board. He had been ordered by the Board to take the levels and make plans for 480 yards of sewer, but the sewer had not been made, as the order had been rescinded at another meeting of the Board. There is an intention of extending this to 1400 yards, so as to carry it to low water. He had recommended that a sewer should be made from the end of London-street, from the Nile to Neville-street, and orders were given him to take the levels. He believed it was to have been so constructed that the waters of the Nile should have fallen into it, and then have gone along it to Neville-street, and to the shore. He did not know whether there was an order on the books to construct the sewer, but it was never done. He was not aware that the water of the Nile could not cleanse the sewer. The Nile was dry in dry weather. The soil was all sand and water. There was one sewer 14 feet deep. The soil was all sand. He did not know whether the tide influenced the water in the subsoil. It is all quicksand after a certain depth. It is found at a depth of 30 inches at Lord-street. It varies in other parts of the town. The refuse from waterclosets, cesspools, and privies is carted away by the commissioners and sold. The expenses are paid out of the rates. The refuse is taken out in buckets. No deodorising powder is used. It is carried from the backs of the houses, and is done during the night. The men employed on that duty are paid at a higher rate than for day-work. The men, to his knowledge had never suffered from disease or fever. They emptied about 36 cesspools a week. He had had no complaint of delay in emptying cesspools and ashpits. They are emptied so promptly after an application, that no complaint is ever made of delay. He had, with the assistance of the inspector of nuisances, made a return of the number of cesspools cemented and not cemented. Most of the drainage from the uncemented cesspools went into the main sewer. He never could find that it percolated into the ground, and he had taken up miles. He did not know that the refuse from the cesspools penetrated into the wells. In Lord-street the cesspools and wells were in the same yards, and could not be far off of each other. The water supply was obtained from pumps and wells. In some the water was not very good. He could not tell whether the water acted on lead. The people are generally content with the water supply. He believed the reason that the soil did not percolate through the cesspools was, that they were caked, so that it does not penetrate. The whole of Lord-street is sewered, and also London-street. Union-street is sewered, also part of Manchester-road; all those sewers are discharged into the main sewer at right angles from Lord-street. There is a main sewer from Lord-street down North-street to the shore. Any of the streets might be easily sewered. Water might be brought down from Sea Bank-road into Neville-street, because there is a good level there, and from the other side they could bring it from the Promenade. The commissioners gradually sewer the streets as their funds will allow. If they go below the quicksand, it is nearly impossible to lay the pipes and joint them. There are cellars in the town; some are damp. He was not aware that any cesspool was sunk so low that a sewer could not be made to take away the bottom water. Some of the cellars are so low that a sewer could not be made to drain them. The commissioners have control over the excavation of cellars. The last winter but one, which was very wet, the cellars to some houses had a considerable quantity of water in them. The connection of house drainage with main sewers has been gradually going on for five years. The greatest quantity of pipes laid down between houses and the sewers was in 1852. It has always been done as soon after application as possible. The cost of making cesspools is from 7*s.* to 12*s.* each. They are about 4 feet deep. When Mr. Newlands was here the water stood at a depth of 46 inches from the surface in the low parts. The depth of the sewer in Neville-street and Lord-street

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is 4 feet 10 inches to the bottom of the sewer. He had not seen any other town with such a subsoil as Southport; and he did not think that the plans adopted elsewhere would do for it. The whole of the sewerage had been directed to one point. He had been acting on a plan. About three years since a sewer was stopped up for a short time by some sticks and rubbish getting into it. Part of the sewage is cast into the river Nile, through a 9-inch pipe. Another part is cast into a drain beyond Pitt-street, by a pipe 12 inches by 9 inches. The sewers when opened are generally free from deposit. A stench is caused by the overflow of cesspools. He had charge of the highways. He had employed eight men generally, sometimes more."

Mr. Richard Pickering said,—"That he was inspector of nuisances under the Improvement Act; and also a police inspector under the county police. He had seven men under him for the district extending over 9 miles. He received 20*l.* a year as inspector of nuisances. He reported regularly in writing to the commissioners. The most frequently reported nuisances were defective ashpits, privies, pigstyes, slaughter-houses, and dirty dwellings. The slaughter-houses were formerly outside of the town, but there were many then in the town. There are four public and three private slaughter-houses. He had not to complain often as to the slaughter-houses. He had a fortnight since to complain of pigstyes. It is customary for the poor in the out districts to keep pigs attached to, but some distance from, their dwellings. There were a few common lodging-houses, but not any for tramps. He has had complaints in two instances where there has been an overflow from cesspools, and he drew attention to the matter. He was aware that there was a nuisance from the mouth of the sewer on the shore whenever there was a sea breeze. The mouth is about 50 or 60 yards from the Promenade, where visitors generally assemble. He considered it the nuisance of Southport, and is the cause of complaints being made. There is an order in the book to remove the mouth of the sewer to low water mark; a distance of 1400 yards. He had reported a great number of nuisances and they had been attended to; the commissioners were disposed to follow up his reports. He had reported eighty-three nuisances since last October. Thirty pigstyes have been removed since that time—besides other nuisances. Some time since the inhabitants were in the habit of paying 1*s.* for emptying a cesspool, and he believed this charge induced them not to have the cesspools emptied so often as they ought, and I reported so to the commissioners, and the shilling was taken off. The emptying of the cesspools by the commissioners pays itself, by the sale of the manure. The commissioners remove the manure, &c. from the slaughter-houses every other day."

Mr. Johnson, clerk to the commissioners, said,—"That the gasworks cost 5000*l.* The price per 1000 feet is 6*s.* 8*d.* The commissioners received an income from the gasworks. There were 103 public lights in the town. The rate levied for sewerage, lighting, and general purposes was 9*d.* last year and 1*s.* at present. The other rate was the paving and highway rate, which was 1*s.* in the pound, and that rate produced about 850*l.* The gross annual value of property in the town was 22,463*l.*, a deduction of one-sixth was made from that. The assessable value was 17,844*l.* There was about 3753*l.* of gross estimated value of property not yet rated. Southport just began to rise into a town on the establishment of the railway, and is increasing now very rapidly. The commissioners have erected slaughter-houses, a market-house, a town-hall, and gasworks, besides sewerage and paving."

Drainage.—Southport is not sewered, but waterclosets and kitchen sinks are drained into cesspools. The surrounding sand allows the fluid to escape; and as filtration will not remove from water matters in chemical combination, and as wells are sunk in the same subsoil, much of the water is tainted. Many of the commissioners seem to think there are local difficulties sufficient to prevent the construction of efficient sewers and drains; should this prove to be the case it will be a barrier to the increase of the town and reduce the value of land for building purposes. Sewers and drains may not be formed so cheaply as in districts having a better fall and a firmer subsoil; but the local difficulties in Southport (a flat surface and quicksand subsoil) may be overcome. The work must be done if the town is to retain its character for salubrity.

Waterworks.—At the time of the inquiry there were no public waterworks in the town. The inhabitants had to depend entirely for their supply on wells and pumps sunk into the subsoil. The impurity of the water in certain wells has been matter of complaint, and, from the proximity of the cesspools to the wells, not without cause. Sand affords an easy channel for percolation. The condition of the water in Southport led to the formation of a company and an application to parliament. They undertake to supply the township of North Meols, of which Southport forms a part, and adjoining townships. The capital of the company is fixed at 16,000*l.* in 1600 shares of 10*l.* each, and the company may, after the whole of the 16,000*l.* is paid up, raise a further sum of 4000*l.* by the way of mortgage. Within three years from the passing of the Act, the company undertake to supply Southport with water. It is proposed to be obtained by making a well near Scarisbrick windmill, about six miles from the town. The following is the maximum rate of charge fixed by the Act.

	l.	*s.*	
Houses of 20*l.* and under	7	10	per cent.
„ exceeding 20*l.* and not exceeding 40*l.*	7	0	„
„ „ 40*l.* „ „ 60*l.*	6	10	„
„ „ 60*l.* „ „ 80*l.*	6	0	„
„ „ 80*l.* „ „ 100*l.*	5	10	„
„ „ 100*l.*	5	0	„

For each watercloset and bath the following extra charge is to be paid:—

Houses not exceeding 10*l.*	4*s.*	per annum.
„ exceeding 10*l.* and not exceeding 20*l.*	6	„
„ „ 20*l.* „ „ 40*l.*	8	„
„ „ 40*l.* „ „ 80*l.*	10	„
„ „ 80*l.*	12	„

If there is more than one bath or watercloset in any house, there is to be only 4*s.* for each additional bath or watercloset.

The improvement commissioners are to be supplied with water for flushing sewers and watering streets, at a charge not exceeding 5*d.* per 1000 gallons.

Conclusions.—That the town of Southport is governed by commissioners holding large powers under a local Act.

That the petitioners in favour of inquiry proved the existence of local nuisances, defective drainage, &c.

That complaints were made of excessive local expenditure.

That many of the commissioners, and other inhabitants, consider their existing powers ample for all purposes of local government, and expressed feelings of opposition to the introduction of the Public Health Act.

Recommendation.—As the commissioners have the power to do much, if not all, required by the Public Health Act, I beg respectfully to recommend that no further proceedings be taken by your honourable Board, unless upon some subsequent and stronger expression of local opinion.

SEWERAGE, DRAINAGE, AND WATER SUPPLY OF SMETHWICK, STAFFORD.

By Robert Rawlinson, C.E., Superintending Inspector.

(*Abstract of Report to the Board of Health*)

Smethwick is a hamlet in the parish of Harborne, county of Stafford, South Offlow hundred, King's Norton union, about three miles and a half west from Birmingham. There has been a rapid increase of houses within the last ten years, consequent upon an establishment of large chemical works and workshops for the manufacture of iron, steel, glass and other articles. There are the works of Messrs. Fox and Henderson, the Messrs. Chance (glass), Muntz's metal works, patent tube works, Soho foundry, plate glass works, patent rivet works, railway carriage works, several large iron smelting works, chemical works, soap works, &c. There are canal and railway communications through the district.

The houses are for the most part built of bricks and covered with Bangor slates. Many of the footwalks are paved with bricks. Like most other districts in England which have grown up rapidly without local government, streets have no regularity, houses have no architectural beauty. There are many nuisances which individuals cannot free themselves from,—cesspools, middens, foul gutters, unformed streets, and dirty roads.

Local Geology.—New red sandstone and carboniferous strata form the subsoil of the hamlet, but no coal mines are worked in it, although it is considered coals are workable. No ironstone has been raised, nor are any mining operations carried on; coal and ironstone abound in the district. The surface has sufficient

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undulation and fall to allow of sewers and drains working easily. Soft rock, alluvial clay, marl, sand, gravel, or varying mixtures of these, constitute the strata through which sewers and drains will have to be formed; quicksand is frequently met with in such districts, but generally in "pot holes" and not to an extent capable of rendering the execution of works very dangerous, if due care be taken in their execution.

Meteorology.—The average fall of rain, as observed in the district, over a series of years, amounts to 26 inches annually; the amount of evaporation to 32 inches annually. During thunder showers, or extraordinary storms, from 1 to 2 inches of rain fall within the hour, producing surface floods, which do much damage at the valley outfalls, if works or houses have been improperly placed, or if the surface has been altered without due forethought and provision for such contingencies.

Population.—The increase in population has been rapid, especially since 1831. The establishment of glass-works, iron-works, &c., in the hamlet, or in the immediate neighbourhood, has contributed to this increase of population. In 1841 there were 5·1 persons to each inhabited house, and 5·13 in 1851.

Local Government.—There are no local Acts in force for any of the purposes contemplated by the Public Health Act. There is no local government other than through the public Acts of the kingdom; churchwardens, highway surveyors, and guardians of the poor, are appointed, but their power does not extend over new roads and streets, of which there are many. There are about 17 miles of public roads and streets under the charge of surveyors annually elected. These gentlemen may not know anything of road-making, and may have their own business to attend to. Continuous superintendence by some person properly educated as a road surveyor is necessary to the efficient and economical maintenance of roads and streets.

Local Water Supply.—There are no public works of water supply in the district. Water is obtained from springs, wells, pumps, and by storing rain. The well and pump water is hard, the rain water is contaminated by dust and soot. Many persons have to obtain water at distances of thirty yards or more, and the poor generally have no adequate means of storing water but in open vessels, which must stand exposed in their living rooms. Private wells are sunk from a few yards in depth to several score feet in depth, (some wells are upwards of 100 feet deep.) The surface water of the south Staffordshire district is contaminated by the sewage of about 300,000 persons, by water pumped from coal and iron mines, by refuse washing from gasworks, chemical, and other large works. The water of the Tame contains upwards of 70 grains of solid matter in each gallon of its water, and is about 25° of hardness, which unfits it for drinking or even washing purposes. It is scarcely possible surface water can be found in the immediate vicinity fit to supply the district on a large scale, but full examination should be made before new works are commenced.

Sewers and Drains.—There is no system of sewers and drains, nor any local power to form one; there are consequently many nuisances.

Evidence as to Drainage.—The following evidence was given as to the drainage of the hamlet:—

Mr. Wm. Mantle said,—"He thought he could show by evidence that the hamlet was altogether without drainage works. In consequence of his house being undrained, great inconvenience and much apprehension had arisen. His house belonged to one of the most determined opponents of the inquiry. All the soap-suds and refuse of the kitchen and brewhouse were conveyed by an open gutter through an open sink into a square building at the back of the privy behind the house, and the refuse of the house was allowed to accumulate in that receptacle. In the early part of the summer the smells were so bad that they were a constant source of apprehension. His house was without any means of drainage,—that the next house was much in the same position."

Mr. R. L. Chance, as one of the largest ratepayers, and one of the original promoters of the inquiry, stated why he had first set the inquiry on foot,—"About twelve years since they established a dispensary at the manufactory, and they learned from the medical attendant that in about forty cottages connected with the premises called Scotch-row, there was a great deal of diarrhœa. It was found that those cottages were not properly drained. He had them drained, and from that time his medical man had but a very small number of patients in them; whilst, at the same time, in the midst of 1700 persons employed in the works, their medical man had the largest practice of any surgeon in that part of the country. Sickness had prevailed to such an extent, that the attention of himself and partners had been directed to the subject, and had led to a desire that to the residences of their workmen generally the same benefits should be extended, so far as drainage was concerned, as were extended to the cottages before named. He thought that if a building society was established in Smethwick, with a capital, say of 100,000*l.*, for the purpose of erecting proper houses, properly drained and ventilated, he had no doubt that in ten years a great deal of money would be saved by the parish. In his manufactory they had no outlet for drainage. If they took it into Spon-lane they had no sewer, and they had therefore to convey it to a cesspool, which was of course a great nuisance to the public. He had no pecuniary interest in promoting the Public Health Act, either on account of his property in George-street or elsewhere; at present he paid nearly one-eighth part of the rates on that property. The only interest he had was the welfare of the working classes. He believed that about one-half of his workpeople resided on the West Bromwich side, and the other half on the Smethwick side of the parish boundary. He thought the tendency was to have cottages built in Smethwick. Mr. Davies was the medical gentleman they had engaged for their workpeople; he had scarcely any other practice than amongst their men."

Mr. Forster remarked,—"With regard to Scotch-row, twelve years ago there was no surface drainage. He had the footway paved and surface drains put down, and the consequence was a great improvement in the health of the inhabitants. The refuse was put into a cesspool and was given to the farmers, who carted it away. Sometimes it overflowed into the canal, and the company complained of it. The cottages were whitewashed once a year; brushes and whitewash were provided for the inhabitants. When the place was drained, the pig-troughs and privies were put a considerable distance back from the houses. With respect to George-street he had had men laid up from low fevers, arising from the want of sewers. There was in fact no drainage; cellars stand full of water, and some persons had to raise their cellar floors 2 feet to place them above the water-level. He was not very sure that all the water flowed in from the surface; much of it might be spring water. He had known persons sink wells, with a privy and cesspool not far off. He had never in any other place seen anything like the state of George-street. In his own house there was a surface grate and cesspool behind his door, and the refuse of about twenty cottages came down to it. He was leaving the house in consequence. There were about twenty to twenty-five houses in George-street. He spoke of Joseph Neill's house in particular, when he stated that there was water in the cellars of the houses. One half of Messrs. Chance's workmen resided in West Bromwich, but he did not think any part of that place was so bad as George-street."

Mr. C. Hicks said,—"That when he first entered on the duties of inspector of nuisances, his attention was called to the defective state of the house-drainage, and the bad condition of the roads. He held in his hand a list of places, which, however, he did not intend to put in, as he did not wish to mention names unnecessarily, but he thought it comprehended every street in the place, or nearly so, and justified him in stating that there was not any one part of the hamlet but what was in a very lamentable state of defective sewerage and drainage. He made that statement quite deliberately. His own house was an illustration of the want of drainage. His cellar was full of water. There were many blocks of houses where there was no drainage at all. The refuse from these houses found its way sometimes into the front street, sometimes into the gardens at the back; and in all cases there was the greatest necessity for the application of the Public Health Act."

Mr. Richard Clarke, land surveyor, of Birmingham, gave evidence,—"He had known Smethwick since 1839, and could state some of the inconveniences arising from a want of arterial drainage in the hamlet. Being engaged in laying out several estates for building purposes, he found great difficulty in doing so in consequence of there being no main sewers. One of these estates consisted of 32 acres of land, near the windmill, on which had been made four streets 14 yards wide, and it was the intention to properly drain and sewer them; but they could not do so in consequence of there being no arterial drainage. The land owners adjoining would not permit them to drain through their estates, and consequently the idea of sewering was abandoned. When people came to build in the new streets, they would find

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their cellars full of water. In some instances that was the case then, and occasioned great inconvenience and complaints. If any one went round the hamlet, they would see water lying on the surface of the roads, in some parts they would find pools of filth. At another estate which he laid out, there was a watercourse which afforded an outlet. Arterial drainage was possible there, and was accordingly put down. The same thing would be done in other cases if it were practicable. He had noticed, particularly near the soap works, that there were a great number of new houses being erected, and he found that the drainage ran down the gardens into a ditch at the back of some building lots, through other building lots, and even under the entry of a house. It was the case generally throughout Smethwick, that the houses were either drained down the bottom of the gardens, and the refuse allowed to lie there stagnant and an annoyance, or to run over the footpath in front."

Evidence as to Water Supply.—Mr. Martin said—"His house was without any supply of water; he had to send about 30 yards for it, which caused a considerable expense and waste of time during the year."

Mr. Forster remarked,—"That as for water it was more or less carried; some of the inhabitants it was true, have pumps. He thought that the local sub-stratum was gravelly, and that if they sunk for 100 feet, clay would be found. He thought the wells were not sunk more than 100 feet. There were several pumps in George-street, but he was not aware that every house-yard had a pump.

Mr. Hicks said,—"He heard complaints every day of the bad quality of water. The wells were sometimes sunk near privies, and he knew numbers of people who told him they could not drink the water. He also observed in some places notices stuck up to the effect that persons taking water from the pumps would be prosecuted."

Mr. Samuel Gosling remarked,—"That there was no place in existence better supplied with water than Smethwick. He had heard no complaints on the subject. By sinking they could get a good supply of pure water close to their back doors throughout the district. He had only to go down 9 yards to get 10 or 11 feet of water. He sunk a well fifteen years ago, which was 6 yards deep, and it cost 14*s.* per yard. It had probably cost him 2*l.* 10*s.* since. It supplied six houses, and persons often came from other places to it."

Water may be abundant in a district, and yet be scarce to the residents. At 30 yards distance, however abundant, it will not be used as regularly nor as fully as health and cleanliness require. Pumps shut from the poor indicate a scarcity. "Pure water" cannot be drawn from a tainted subsoil, and where sewage and nightsoil refuse stand upon a gravelly subsoil, infiltration takes place.

Conclusions.—That there is no local Act in force for any of the purposes contemplated by the Public Health Act.

That the promoters wish the Public Health Act to be applied.

That there are many local nuisances, which the medical witnesses stated they believed caused disease and deaths in excess.

That public lighting is defective.

That the water-supply is from wells, pumps, and rain. That some of the spring-water is contaminated, and that the supply of water to the poor is deficient.

That many cellars contain stagnant water, and that many dwelling-houses are damp.

That roads and streets are unformed, uncleansed, and dirty.

That subsoil and atmosphere are both favourable to health, if preserved from sewage and other contamination.

That, according to medical testimony, there is preventible disease (fever).

That population has increased greatly in the township, and that there is every probability of a further increase.

Recommendations.—That the Public Health Act be applied to the hamlet of Smethwick. That the Local Board to be elected under the said Public Health Act consist of fifteen persons.

That every person shall, at the time of his election as a member of the said Local Board, and so long as he shall continue in office by virtue of such election, be resident, as in the said Public Health Act, 1848, is required, and be seised and possessed of real or personal estate, or both to the value or amount of not less than 700*l.*, or shall be so resident and rated to the relief of the poor of the parish upon an annual value of not less than 25*l.*

SEWERAGE, DRAINAGE, AND WATER SUPPLY OF CAMBORNE, CORNWALL.

By Robert Rawlinson, Esq., C.E., Superintending Inspector.

(*Abstract of a Report to the Board of Health*).

Camborne, a market town and parish in the hundred of Penwith, county of Cornwall, four miles west of Redruth, and about 24 miles from Land's-End. The name Camborne is said to have been derived from a well in the neighbourhood,—Cam-burne well,—a spring from the granite. Formerly this well was much resorted to by both the aged and the young, on account of the reputed virtues of the water. The town of Camborne has increased rapidly since the commencement of the present century. The population for the parish is given in the census for 1851 as 12,887; and for the town, 6547.

The Dolcoath copper mine is in the parish; the works are upwards of 1400 feet deep, and extend many hundred fathoms laterally; upwards of 1000 men have been employed at one time in these workings. Several new streets have recently been added to the town.

Local Geology.—The eastern and south-eastern sides of the parish of Camborne are situate on granite, much of the area being high and barren. On the boundaries of the granite and slate are numerous copper mines, in which the population are engaged.

The granite immediately in contact with the slate consists of compact felspar or porphyry. The slate in contact with the granite has received the various names of "greywacke," "greenstone," "claystone," and "killas." It appears to consist almost entirely of compact felspar, coloured purple or blue.

Between the mining district and a line drawn east and west across the parish, the land is very good, but northerly, and near the sea, it forms sheep pasturage.

Local Mortality.—In the year 1832 there were 13 cases of cholera in Camborne. Cholera also prevailed in the years 1848 and 1849. The Registrar-General, in his quarterly return for December 1852, states, "The number of deaths in Camborne is above the average, the increase being chiefly attributable to the prevalence of typhus fever." Some parts of the town, where the deaths from this cause have been most numerous, ought, from its natural elevated position, to have been most exempt; but, owing to the neglect of sanitary arrangements in the buildings and the drainage of the streets, fever generally exists there to a greater or less extent.

Roads and Streets.—The roads and streets are maintained by a rate which amounts to 1*s.* 6*d.* in the pound.

There are about 35 miles of highways and footpaths, and 3 miles of streets. The streets and channels are not properly cleansed. In dry weather they are dusty, in wet weather they are some inches deep in mud; after a cattle fair the streets are most offensive, the refuse remaining unmoved for several days.

Sewerage and Drainage.—There are a few surface drains to pass rain-water from the roads, but no sewers adequate for town and house purposes.

Local Nuisances.—There are many nuisances in the town; foul gutters, heaps of refuse near houses, cesspools, and foul ditches. This description is as applicable to new streets as to older ones.

Water Supply.—There is no public water supply. The inhabitants at present obtain water from pumps and wells, or from rain stored in tubs and cisterns. From a return furnished I learned that there were only 20 public pumps and wells, and 12 private. The wells are on an average 60 feet in depth. Many of the wells are open, and water has to be drawn up in a bucket.

Analyses of Local Waters.—The following analyses of local waters were made subsequent to the inquiry:—

"Laboratory, Whitehall, Oct. 15, 1853.

Report on a Preliminary Examination of Four Specimens of Water sent from Camborne.

These specimens were sent in glass bottles, corked and labelled.

1. Water from draw-well in Gas-street.
2. Rain-water from Camborne.
3. Water from Gustavus mine, a quarter of a mile below Camborne; and,
4. Water from Wheel Gin adit, the proposed source of supply.

1. The water from the draw-well had a brownish tinge, contained numerous floating particles of vegetable matter, and had a

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vapid taste. Tests showed the presence of sulphate of magnesia, bicarbonate of lime, and common salt, with a considerable quantity of vegetable matter. The hardness, which was about 32°, is of an unpleasant kind, as there is much curd formed by the magnesia. This water is not at all suitable for supplying a district.

2. The specimen of rain-water from Camborne was clear and colourless, and had scarcely any taste of soot, but contained a little vegetable matter, possibly obtained from the water-butt, or from fallen leaves. Tests showed the presence of a little sulphate of lime, and a trace of common salt, together with a little vegetable matter. The hardness was 4¼°, which is somewhat more than rain-water commonly has. It contains from five to six grains of saline matter per gallon, chiefly sulphate of lime, probably derived from the roof from off which the water was collected.

3. The water from Gustavus mine was bright and clear, free from colour or smell. Tests showed the presence of sulphate and bicarbonate of lime, and magnesia, with a little common salt. The hardness was 6·6°.

4. The water from Wheel Gin adit is bright and clear, perfectly free from taste, colour, or smell. It contains only five grains per gallon of saline matter. Tests showed the presence of a little sulphate of lime, bicarbonate of magnesia, and a trace of common salt. The hardness is only 3°. This water is free from any injurious metallic impregnation; it is admirably adapted for the source of supply, and any district is most fortunate that is within reach of water so well adapted for drinking, cooking, washing, and all domestic purposes. It is softer than rain-water is usually found as stored for use, not half as hard as the water of the Gustavus mine, which in most districts would be considered excellent, and not one-tenth as hard as that of the draw-well which it is presumed is a source now commonly resorted to. It is scarcely possible to compare these two waters for washing purposes, as it would be scarcely possible to wash with the well water without previous softening, but if it were used in its natural state 100 gallons would destroy about 64 ounces of soap, while an equal quantity of that proposed for the source of supply would destroy only 7½ ounces. For tea making also it will doubtless be found very economical to substitute the soft for the hard water. The quantity sent for examination was too small to try this by experiment, but there is frequently a saving of from quarter to one-half of the tea used by making it with soft instead of hard water, a saving which together with that of soap or the expense of collecting and storing rain-water, would pay a large part of the cost of procuring soft and pure water.

The draw-well water contains so large a quantity of both saline and organic impurity, that it can hardly fail to be injurious. It is moreover so little agreeable to drink that the substitution for it of the pure water proposed is likely to be promotive of habits of temperance, and thus indirectly but powerfully increase the morality as well as the health of the district.

(Signed) P. H. Holland."

New Waterworks.—New waterworks may be established for the supply of Camborne if the water flowing waste from Wheel Gin adit can be obtained.

A covered reservoir, capable of storing not less than thirty hours' flow, should be formed; and from this cast-iron mains and branches should be laid to the town, and through each street. House service-pipes may be of galvanised wrought-iron tube, with screw joints and patent screw-down taps; the water should be taken within each tenement.

The income will warrant an expenditure upon works of 5000*l.*, paying interest, management, and repaying the capital in thirty years. Detailed estimates should, however, be obtained before any works are commenced. Water so soft and pure will be cheap at a greater cost than the sum stated.

Lighting.—There are gas-works in the district, established in the year 1835. There are no public lights. Gas is charged to private consumers 9*s.* per thousand feet. It is used in shops, hotels, and in some private houses. The works are small. Five retorts in use in winter; three in summer. Annual make about 600,000 cube feet.

Conclusions.—That the parish of Camborne is a place having a known and defined boundary.

That the present rate of mortality is excessive.

That there is no local Act of Parliament in force for purposes contemplated by the Public Health Act.

That the government of the town and parish is imperfectly carried on under the general Acts of the country.

That there is neither sewerage nor drainage.

That there are many nuisances dangerous to health.

That there is no public water supply, and the existing supply is very deficient.

That cesspools are attached to dwelling houses, and there are many nuisances arising from open cesspools and exposed middens.

That there are nuisances arising from slaughter-houses.

That roads and lanes are unpaved.

That many houses and rooms are so imperfectly ventilated as to induce disease in excess.

That preventible disease (fever) is common, and that the mortality from such disease is excessive and costly.

Recommendations.—That the Public Health Act, 1848, be applied to the parish of Camborne.

That the present boundaries of the parish be the boundaries of the district to which the Act be applied.

That the Local Board of Health to be elected under the Act consist of 12 persons.

That every person at the time of his election as a member of the Local Board, and so long as he continue in office by virtue of such election, shall be seised or possessed of real or personal estate, or both, to the value of not less than 200*l.*, or be rated to the relief of the poor of the parish of Camborne upon an annual value of not less than 10*l.*

SEWERAGE, DRAINAGE, AND WATER SUPPLY OF ULVERSTONE, LANCASTER.

By Robert Rawlinson, C.E., Superintending Inspector.

(*Abstract of Report to the Board of Health*).

Having received instructions from your honourable Board to visit Ulverstone, in consequence of its having been ascertained from the last return for the time being, made up by the Registrar General of births, marriages, and deaths, from the deaths registered in a period of not less than seven years, that the number of deaths annually in Ulverstone have on an average exceeded the proportion of twenty-three to a thousand of the population, the usual notice was issued, and was duly posted and advertised as the Act directs. At the time and place named I commenced the inquiry.

Remarks on Preventible Disease.—The terms "preventible disease" are not so well understood at present as they will be when proper sanitary works shall have been executed, affording the contrast necessary to judge by, and when local authorities pay more attention to the means of securing health. There are many circumstances and conditions under which men are placed where personal care may prevent disease; but there are, also, conditions beyond the control of individuals. The inhabitants of a town are dependent upon their local government for proper sewers and drains, for clean streets, for good pavements, and for a regular removal of all refuse liable to taint the surrounding atmosphere. The poor, who live in cottages and in room tenements, are entirely dependent upon those who build or let these places. Improvement must be commenced by those who have the power and the means, and it will require years of teaching and unceasing care, first to school men into cleanly habits, and afterwards to preserve decency and order. Generation after generation of men, termed civilised, have been born into this world amidst filth and pestilental vapours, until nature has, in some measure, acclimated the constitution and deadened the senses; the evils of centuries cannot be eradicated but by time. It is natural for man to seek pure air, but this instinct has been destroyed, and use only will restore it. In a climate cold and changeable, warmth is necessary to active vitality, and, to secure heat necessary to comfort, the poor block all means of ventilation, and so prevent any change of air; this is one fertile source of "preventible disease." In towns houses are crowded together in narrow streets, in confined lanes, and in close courts; frequently there is no form of surface pavement; there are no sewers, and the refuse accumulation of months is stored within some houses and close upon others; decomposition takes place, and a tainted atmosphere exists all the year round. This is another cause of "preventible disease." Both these causes are in full activity in Ulverstone at this time.

The town of Ulverstone is pleasantly situated, and has externally a cleanly appearance; but, like most old towns, the streets are very irregular in width, few of the houses are in line, and

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those of one, two, or more stories abut upon each other. The principal streets, and some of the back courts and yards, are paved with boulders, and others are formed of broken stone, "Macadam." Iron ore, "hematite," is carted from the mines through the town to the canal, and this imparting its red colour to the surface attracts the attention of strangers. Most of the houses are built of the rubble stone of the district, and are plastered, rough cast, and coloured, or lime washed. It is this which imparts an air of cleanliness to the outside, which is not confirmed by a more close inspection. The houses in most parts of the town are confined, by being crowded too much together; the cottages are small and the rooms low; some windows are not large enough for light, and in many chamber windows only one small casement can be opened to admit change of air. The ground floors are formed with flags or stone of the district, and are consequently cold and damp. This is especially the case where the land behind the houses slopes towards the streets. There are several natural watercourses through the town, which are now, for the most part, covered over. Privies, cesspools, and middens are in close proximity to houses, and in some instances they are in contact with the walls, and even beneath sleeping rooms. The whole subsoil is porous, yielding water at small depths from the surface, and there are numerous pumps for the supply of water, many of these being near cesspools and middens. Slop water is thrown out on to the surface, and flows along pebble-paved channels into rubble drains, connected with natural watercourses which intersect the town. There are houses at the lower end of the town built over or near streams receiving the upper drainage, from which fever was said never to be absent. Drains of dry rubble stone, square in sectional form, have been laid down in several parts of the town within the last few years. There has been more sickness (fever) since this time.

Local Geology.—Ulverstone stands upon alluvium, consisting of gravel, sand, and clay, in various states of admixture, overlaying silurian rocks. Carboniferous or mountain limestone exists at the surface to the south, and clay slate forms the mountains to the north. The district is open towards Morecambe Bay, or south-west, but there are hills of several hundred feet elevation immediately behind the town, forming the southern portion of the Lake district. The shores of the bay of Morecambe have been wasting for many generations; large tracts of land have been submerged or washed away since historic periods. Leven sands, Kerr sands, and Pile sands, cover the remains of ancient forests; peat is found on the shore below the sea-washed sand from Hawcoat by Barrow and on to Kampside. In the channel betwixt the islands of Foulney, Old Barron, and Walney, peat-moss and trunks of trees are frequently washed up. The land of the parish of Aldingham has been wasted by the tides, tradition placing the church of Aldingham in the centre of the parish.

This wasting of lands near the sea is common to England. There are exceptions, where, from local peculiarities, land is forming, but the result upon the whole is loss; and this has taken place since the earliest historic periods. The parishes of Lancashire and Cheshire are generally large, those on the sea border are usually small, and the names of some townships alone remain, the whole of the land having been wasted. These catastrophes are too general to be merely superficial; the probability is that the whole island is subsiding.

Local Statistics.—Ulverstone township: population in 1851, 6742. Houses in 1851, inhabited, 1249, uninhabited, 24; building, 19. The population of the parish of Ulverstone in 1851 was 10,623.

Local Acts of Parliament. — Ulverstone Waterworks Act, 15 and 16 Vict. sess. 1852. This is the only Act in force for any of the purposes contemplated by the Public Health Act.

Highways and Streets.—The highways and streets are repaired under the powers of the highway Act.

Sewers and Drains.—There is no general system of sewers and drains capable of removing the sewage of the district. There are drains made of dry rubble to remove surface water. Street and yard channels are foul with liquid refuse.

Present Water Supply. — The supply of water was obtained from wells, pumps, and rain. The new works will give a more abundant and better supply.

Lighting.—The town is lighted by gas.

Burial Grounds.—There are five burial grounds; one each at St. Mary's church, Trinity church, Independent chapel, Friends' meeting-house, Roman Catholic chapel. These grounds were said not to be over-crowded. New ground had recently been added at St. Mary's church. A general cemetery at a distance from houses will be an advantage.

Water Supply.—New Works.—The town will be supplied with water by a company under the powers of an Act passed in 1852. By that Act the capital subscribed by the shareholders is fixed at 8000*l.*, with a power, when that amount has been paid up, to raise 2600*l.* by mortgage. The opposition to that Act (including the cost of carrying a second bill into parliament and then abandoned), is stated to have been upwards of 2000*l.*

Analysis of Water.—The following is the analysis of Pennington Beck Water, in 1852, by Dr. Lyon Playfair:—

	Grs. Imp. Gall.
Silica	·080
Iron and alumina	·140
Carbonate of lime	1·473
Sulphate of zinc	·717
Carbonate magnesia	·880
Sulphate of soda	·716
Chlorides, potassium and sodium	1·430
	5·436

The hardness by soap test was 3·2.

Before the passing of the company's Act the town was imperfectly supplied from pumps and wells. In 1852, the number of houses was 1327, and of pumps 267. These pumps supply 823 houses, leaving 504 houses without pumps.

Ulverstone Gasworks.—Gasworks were established in Ulverstone about twenty years since. The following statement was supplied by the secretary of this company:—

"Number of public lamps 83. Lighted September, October, November, December, January, February, March, and part of April, twenty nights in each month, from dusk till six o'clock. Charge for lighting, cleaning, repairing, and all connected therewith, average about 1*l.* 17*s.* 6*d.* per lamp, if the whole nine months are lighted. Gas produced about 2,200,000 cubic feet per annum. Wigan Cannel only used. Price per 1000 feet 6*s.* 8*d.*; length of mains 3¾ miles. The refuse tar and water not allowed to communicate with any watercourse, except by accident; it is usually carted on to the sand and there destroyed."

Remarks on Sewers and Drains.—In sewering the town great care must be taken to improve all the surface and valley outlets, so as to remove storm waters. Natural watercourses must not be arched over, so as to turn them into sewers; but the sewers must be distinct and confined to the work of house and town drainage. Arrangements for flushing must be made at all convenient points.

The outlets of all sewers must be protected from any indraught, and proper means of ventilation should be provided at the highest points of the branches. House drains should not communicate direct with the sewers, but there must be proper traps and breaks so as effectually to prevent any internal atmospheric contamination.

Cesspools or open soil-pits cannot be used without danger to health, and masses of filth liable to putrefactive fermentation are noxious in any town district, but a mixture of sea-water adds deadly power to gases so generated.

All sewers and drains laid in porous sand or earth must be made water-tight, and means should be provided to preserve them free from deposit. Natural watercourses, draining large areas of land, should not be covered in to act as sewers, but the waters of such may be used to "flush" or cleanse the sewers at intervals.

Rooms in which waterclosets and soil-pans are fixed, should, in all cases, have full and free means for ventilation; where practicable, they should be placed against external walls. Drains for kitchen and other sinks should not enter house walls, but the pipes should be carried into an external trap placed at the head of such drains.

Conclusions.—That the town of Ulverstone contains many nuisances injurious to health which are removable.

That there are neither proper sewers nor drains.

That cesspools are crowded amongst cottages, and in some cases are situate beneath sleeping rooms.

That fevers prevail in the houses of the poor.

That there is no local governing body having power to initiate and carry out proper works.

Recommendations.—As the inquiry was made upon the mortality, and not upon petition, and as the return made by the Registrar General was disputed, for reasons stated, I beg to

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recommend that no further proceedings be taken by your honourable Board, unless an authorised requisition from the ratepayers be forwarded, asking for the Act to be applied.

Should the prayer of such further requisition be granted I beg to recommend that the Public Health Act be applied to the town and township of Ulverstone. That the Local Board to be elected under said Public Health Act consist of twelve persons. That every person shall, at the time of his election as a member of the said Local Board, and so long as he shall continue in office by virtue of such election, be resident, as in the said Public Health Act, 1848, is required, and be seised and possessed of real or personal estate, or both, to the value or amount of not less than 800*l.*, or shall be so resident and rated to the relief of the poor of the parish upon an annual value of not less than 20*l.*

SLIDE AND TONGUE RAILWAY CHAIR.

J. & T. Hostage, and — Tatlock, *Patentees.*

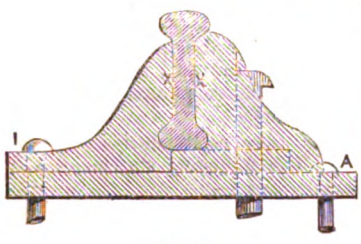

Fig. 1.

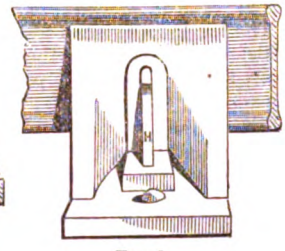

Fig. 5.

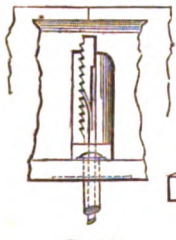

Fig. 6.

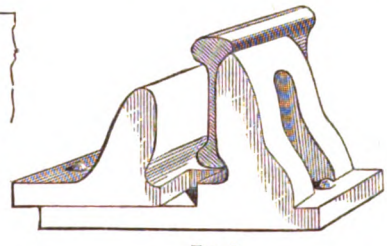

Fig. 2.

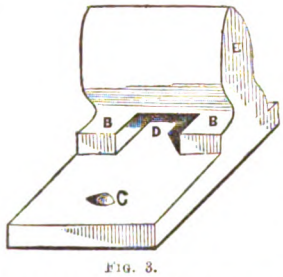

Fig. 3.

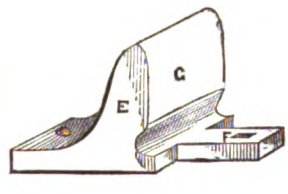

Fig. 4.

In the accompanying engravings, fig. 1 is an elevation of chair when fixed, the dotted lines showing the slide-tongue and cotter; fig. 2, perspective view of chair with slide partially drawn out to admit of rail being taken up or placed; fig. 3, view of fixed part of chair; fig. 4, view of slide and tongue part of chair; fig. 5, end view of chair, showing mode of cottering, &c. The fixed part, fig. 3, is cast with a seat for the rail, and cheek or solid abutment to fit the outside. In laying, this is fastened to the sleeper in the first instance, by the spike A, fig. 1. The immediate seat of the rail or rails B B, fig. 3, is elevated about an inch above the top of the lower plate C, of the chair. There is a space or opening D, in the centre of this seat, and extending under the fixed cheek E, for the admission of the tongue in the other part of the chair F, fig. 4, which space is about 2 inches wide by 1 inch deep.

The slide portion of the chair, fig. 4, is also formed with a cheek G, to fit the rail, and furnished with a projecting tongue F, to fit the space described in the other portion of the chair, and extending so far beyond the outside of the cheek in the fixed part, as to admit a wedge or cotter of wrought-iron H, fig. 5, to be driven down vertically through a slot both in the tongue and bottom of the chair, and some distance into the wooden sleeper; the position of the two slot-holes being such as to allow the wedge to draw the whole up tight. The usual spike I, fig. 1, then secures the slide and bottom plate to the sleeper in the ordinary manner. A thin piece of felt X, fig. 1, will amply remedy any slight inequalities in the ironwork. The "tilt" of the rail to meet the wheel-tyre, may either be provided for in the chair or by adzing the sleeper. Fig. 6 shows another method of fixing cotter by spring and ratchet.

ARTIFICIAL STONE.

W. Hutchison, Tonbridge Wells, *Patentee*, March 28, 1855.

The invention relates to a peculiar preparation of sand, loam, chalk, gravel, shingle, plaster, cements, lime, or other similar loose and friable substances combined with common resin, coal-tar, or other suitable resinous or similar bituminous material, whereby a new compound is produced which may be moulded into blocks of any desired shape, and coloured according to taste. These blocks when completed and hardened are perfectly impervious to wet and vermin, and durable in the highest degree. To manufacture an artificial stone of a dark colour, the patentee employs coal-tar, but if a light artificial stone is required, he generally uses common amber resin, both substances being prepared as hereinafter described.

The tar is freed, in the first place, from all its aqueous and some of its oleaginous constituents by boiling it, and distilling and condensing the same through pipes, until it becomes so far consistent as not to give off any oily or fatty substance to the touch. If properly prepared it will set perfectly hard when cool, and will not yield to impressions.

Previous to submitting the materials to pressure they must be thoroughly dried, which may be effected on metal plates, heated by hot air or hot water, or by placing them on any surface of brick or stone heated by furnaces or otherwise. The proportions used by the patentee are about one gallon of sand or other friable substance to one quart of coal-tar, prepared as before described; or one gallon of sand or other friable substance to about one pint and a quarter of resin in a boiling state. The aforesaid materials are all mixed up in a heated state until they become thoroughly mixed and incorporated; the mass is then compressed in a warm metal mould of any desired form by pressure or stamping.

The moulds employed should be made in two or more pieces, so as to be capable of being thoroughly secured together, and yet readily disengaged when desired. When composed of metal, the mould should be perfectly smooth inside, and the pressure applied gradually. Everything used with the aforesaid process should be kept warm, but the materials when compressed should be relieved from the moulds as soon as moderately cooled. In order to obtain coloured artificial stone, the resinous or bituminous substance may be coloured while in a boiling state, or the sand or other material may be coloured previous to its incorporation with the aforesaid ingredients. If desired, one coloured material may be incorporated on a material of another colour, and both such materials compressed together in a mould while still in a heated state. The black material, or that made with the tar, may be faced with the light material, or that made with the resin, the dark and light material being placed in the mould and compressed at the same time.

According to one mode of operating, the tar or resin, after having been treated as before described, in place of being reduced to a liquid state by boiling may be reduced to a fine powder and mixed with the sand or other material, being also reduced to a powder over a hot plate, and when sufficiently heated so as to become incorporated together, the mass may be compressed into moulds.

The artificial stone prepared by any of the methods hereinbefore described may be again crushed into a fine powder, and mixed with about twenty-eight per cent., more or less, of lime or other plastic material, and used when cold as a cement for internal or external application.

Claim.—The manufacture of artificial stone of any desirable colour by incorporating sand, loam, chalk, gravel, shingle, plaster, cements, lime, or other similar loose and friable substances with tar, resin, or other suitable bituminous or resinous substance, and by compressing the compound mass in moulds, as described.

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BLOWING ENGINE.

Fig. 2.

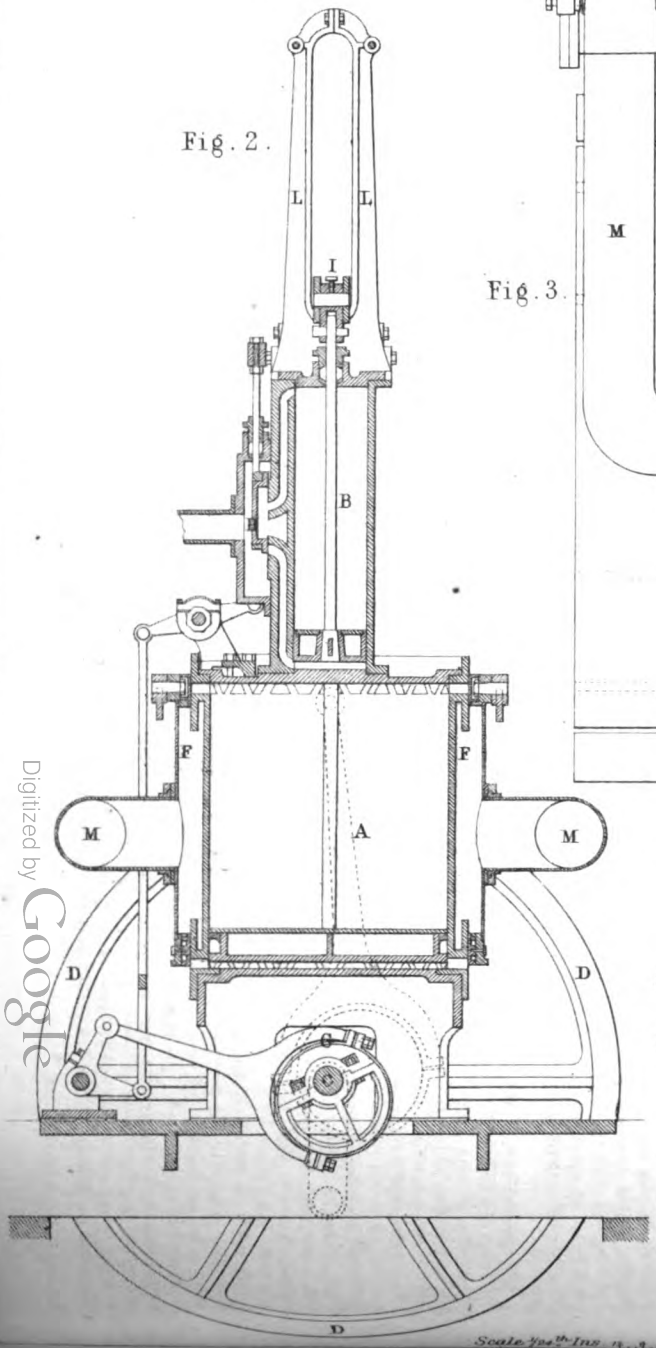


Fig. 3.

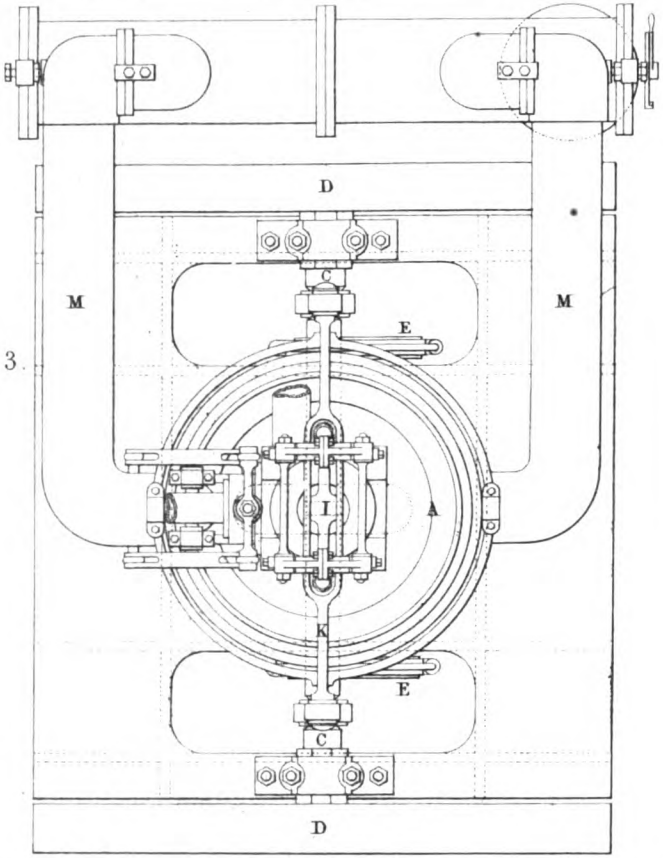
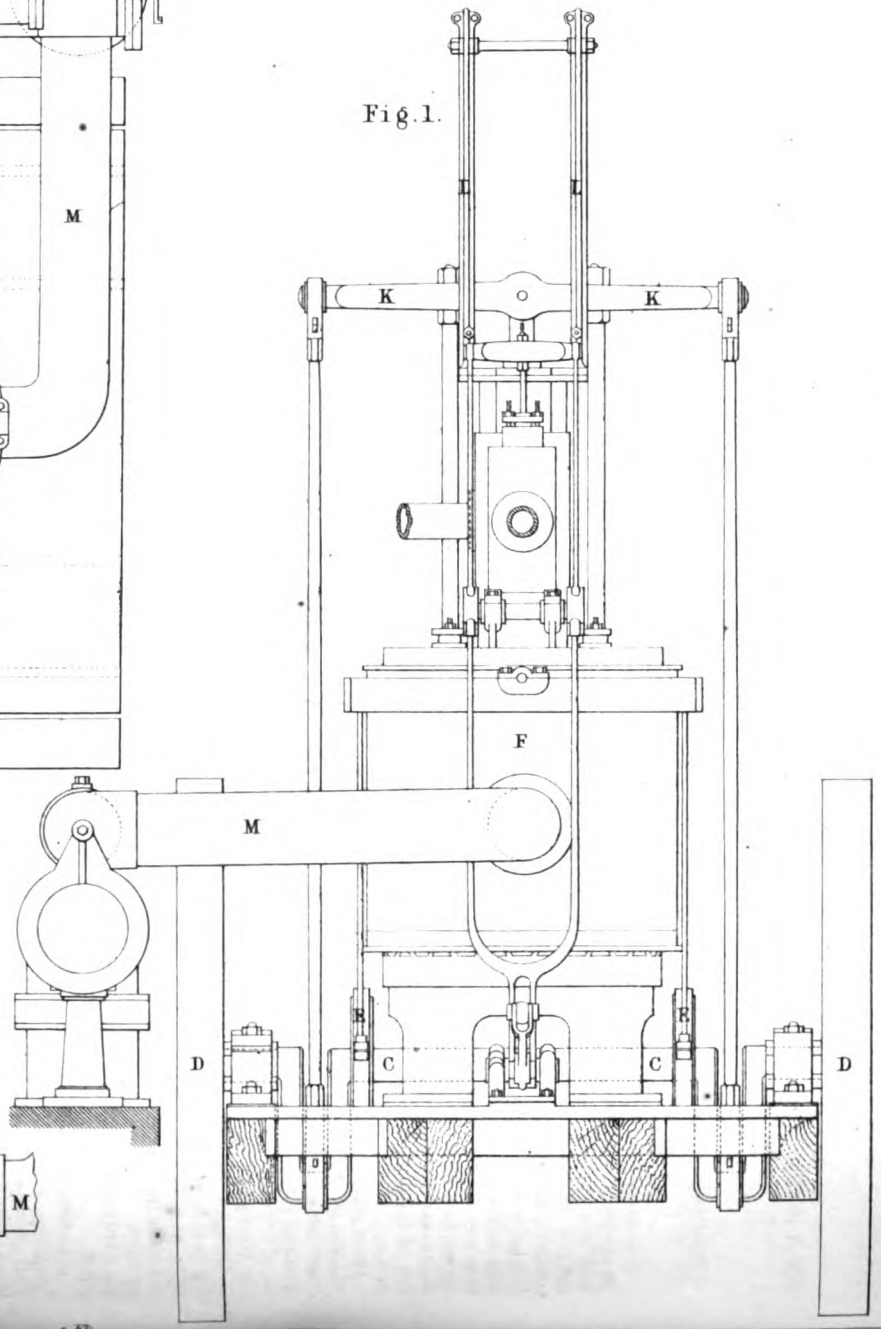
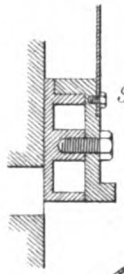


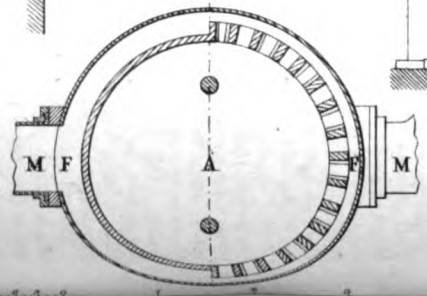
Fig. 1.





Section of Air Valve
1/6th full size.

Fig. 4.



Scale 1/24th Inch 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27

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ON A SET OF BLAST ENGINES MADE FOR THE EAST INDIAN IRON COMPANY.

By Edward A. Cowper.

[*Paper read before the Institution of Mechanical Engineers.*]

(*With an Engraving, Plate* VIII.)

In accordance with the request of the council, that each member should communicate to the Institution the particulars of any work of a novel character in which he may have been engaged, and that would be likely to prove interesting or useful to the members, the following description of a number of blast engines that have been recently made for blowing the furnaces of the East Indian Iron Company has been prepared by the writer; and as so many of our friends are engaged in the production of that one metal, which not only exceeds any other in usefulness, but all the others put together, it is presumed that if the construction of these engines is approved, this Paper will be of some service.

These engines were made to the plans and under the superintendence of Mr. Charles May, the consulting engineer to the East Indian Iron Company, by Messrs. James Watt and Co., to the drawings prepared by the author of this paper. The engines are six in number, two pairs of them being intended to blow air at 2 lb. per square inch as a maximum pressure, and the other pair to blow air at 4 lb. per square inch as a maximum pressure. Fig. 1, is a side elevation of the engine complete, with crank-shaft, wheels, &c. Fig. 2, is a vertical section through the steam and air cylinders, and their valves and passages, and the branch air pipes. Fig. 3, is a plan, and fig. 4 shows a sectional plan taken through the air valve, and the air passages and branch air pipes.

The general form and construction of the engine is that of a "Pedestal or Table Engine;" the air cylinder A, stands on a short pedestal, and itself forms the pedestal or table on which the steam cylinder B, stands. The foundation plate is 6 feet square, and carries a wrought-iron crank-shaft C, in four plummer blocks, having two light fly-wheels D, D, one on each end of the shaft, and the two eccentrics E, E, for driving the air valve F, one on each side of the air cylinder, and the eccentric G, for driving the steam valve H, in the centre. The steam piston has one piston rod fixed in a short cross head I, at the top, and this cross head has two other piston rods for driving the air piston, which pass down outside the steam cylinder through stuffing-boxes in the cover of the air cylinder, and are attached to the air piston. The long cross head K, taking the connecting rods to the cranks, is attached to the short cross head by a pin, so as to allow a little freedom in case of unequal wear; the guides L, L, are attached to the steam cylinder cover.

The air valve F, is made under Mr. Archibald Slate's patent, and is a ring or crown valve entirely enclosing the air cylinder, and is not self-acting by the pressure of the air in any way, but is moved by the pair of eccentrics E, E, at the proper times, so as to give ample passage for the air to move with the greatest freedom, and the valve has such a proportion of lap as to cause the air to be compressed up to the working pressure before it is delivered, thus giving the engine no more work to do than is necessary.

The openings or passages for the air from the air cylinder to the valve are extremely short, and the bars between the openings are made inclined, so as to cause a regular wear on the brass packing rings which form the rubbing face of the valve. The body of the air valve is made of thin sheet iron, neatly curved to two turned cast-iron rings, to which it is well secured by a great number of small bolts; these rings are bored out inside to receive the brass packing rings before mentioned, which are secured in their places by bolts. There are no springs to the brass packing rings, but they are bored out to be a perfect fit to the outside of the air cylinder, and are then cut into eight pieces, and should any wear take place they can be at once adjusted by introducing a thin sheet of paper behind them and screwing them fast in their places again. It should, however, be remarked that this valve is under totally different circumstances from any that have hitherto been made, as it is perfectly in balance, or rather it is suspended perfectly freely, and slides up and down a turned cylindrical surface, and therefore there is no tendency or power to cause wear under any variation in the pressure of the air. The mode in which the two eccentrics drive the air valve is by means of a "Gymbal Ring;" that is to say, there is a wrought-iron ring encircling the air valve and attached to it by two pins opposite each other, and the eccentric rods are attached to the ring at two other points at right angles with the first; thus the air valve is perfectly free.

The air cylinder A, is 30 inches diameter and 2 ft. 6 in. stroke, and the piston makes 80 strokes per minute. The air piston is packed with hemp packing, and has a ring to screw it down; the screws are so arranged that they can be got at by simply unscrewing small plugs in the cylinder cover, when a socket spanner can be introduced to screw the ring down. The air passes into the air cylinder beyond the end of the valve, first at one end and then at the other, and is delivered into the hollow part of the valve, from which it escapes through two light copper branch pipes M, M, placed opposite each other, and having turned joints fitting turned collars fixed on the valve. The other ends of the pipes rest on a small surface or shelf prepared for them, and on which they slide backwards and forwards about $\frac{1}{8}$-inch; these ends of the pipes are curved in the same manner as the other ends, so that the faces are in one plane, and the air main has the faces of its branches surfaced to receive them, as shown in the plan, fig. 3; thus the air is taken equally from each side of the air valve.

The steam valve H, has considerable lap, and is so proportioned as to cut off the steam just after the half stroke and have a very free exhaust.

The boilers are on the Cornish plan, and will be chiefly used with wood as fuel, and the furnaces are made proportionately large for this purpose. The boilers are fed by a donkey engine entirely independent of the blast engines, so that they are complete in themselves, and there is no fear of getting short of water whilst the blast engines stand for "tapping," at which time indeed the boiler should always be fed, if only to keep the steam down a little.

The engines having to be transported some distance up the country, a limit of weight was given, viz., 1 ton for any one part of the engine; and in accordance with this limitation the total weight of a pair of these engines is only 11 tons as compared with 25 tons, the weight of an ordinary blast engine of equal power; and the weight of the heaviest single piece of an ordinary engine is $4\frac{1}{2}$ tons as compared with 1 ton, the weight of the heaviest piece in the new engines. It is therefore evident that the engine can be moved with the greatest facility, and the first pair put to work here for trial simply stood on some balks of timber, and a few small bolts through the bed plates were sufficient to hold them and cause them to work quite steadily; whereas for the ordinary engine a strong building with massive foundations has to be erected.

The method by which a high speed for blast engines has been attained is simply that of moving the air valves for the air, having of course very large valves and passages, instead of letting the air itself move the valves. This arrangement, which was introduced by Mr. Slate to this Institution at the meeting in July, 1850, at once prevents all blow and jar in the working, provided that the lap and lead of the valve are properly proportioned, and allows of the piston being driven at a high velocity, and consequently its diameter may be reduced and its stroke shortened. This mode of working, combined with the fact of two engines working together as a pair with their cranks at right angles, causes such uniformity in the flow of the blast that no regulator of any kind is needed; indeed the variation is hardly perceptible in a mercury guage placed on a very short length of main, whereas the variation on the ordinary plan is very considerable. The pair of engines are arranged to blow together 3600 cubic feet per minute, and are speeded to 80 revolutions per minute, which with 2 ft. 6 in. stroke makes 400 feet per minute, and this they do with the greatest ease and efficiency, owing to the exact manner in which the lap and lead and area of passages, &c., are proportioned; but the author does not wish it to be supposed that he recommends a higher speed, or at all events a much higher speed, for although we have the example of locomotive engines before us every day working at higher speeds, we also know something of the cost of repairs of locomotives working at high speeds, and it is evident that what an iron master wants is a good serviceable engine that will blow steadily on day and night without repairs and stoppages; in addition to these first requisites there are two other advantages which it is certain are attained by this construction of blast engine, namely, first, great regularity of pressure in the blast,

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and secondly, greatly reduced first cost of engine and of foundations.

Discussion.—Mr. FAIRBAIRN (the Chairman) said the engines appeared remarkably compact and small for blowing a furnace, and the uniformity of pressure obtained by them would be an important advantage. There had been a variety of plans advocated for obtaining a blast suitable to the different requirements of the cupola and the blast furnace; and he remembered that at a recent meeting of the British Association the subject had been discussed, and it had been proposed to use the fan for the blast furnace. He understood that there was a furnace near Chesterfield blown by a fan, but he did not know the particulars of its application.

Mr. SAMUEL LLOYD, jun., believed the great difficulty in using the fan for blowing a blast furnace was to get pressure enough for that purpose, and he understood it had been found impracticable to obtain sufficient pressure of blast from the fan to force air enough into the furnace.

Mr. FAIRBAIRN observed that it had been argued on the other hand in favour of the fan, that the operations of the blast furnace depended on the quantity of air delivered into the furnace, rather than upon the pressure at which it was delivered, and this view of the question was, he believed, more generally entertained now than previously, but he had not heard the results of the practical trial of the fan for blast furnaces. He mentioned that a number of blowing machines of different constructions were to be seen at the French Exhibition, showing a great amount of skill and ingenuity; in one of them, the general plan of the machine was much the same as that described in the paper, having an upright cylinder like that shown in the Engraving, with a very large flat slide valve working on each side, for the admission and discharge of the air.

Mr. COWPER observed that there was a great practical advantage in the engines described in the paper, from the air-valve having no side pressure whatever upon it, as it was a circular valve entirely surrounding the blast cylinder, and consequently was perfectly in balance; and being guided very steadily, by fitting the cylinder at top and bottom, its motion was very smooth, and the wear upon it would be very slight.

Mr. SAMUEL LLOYD, jun., enquired whether the small engines were to be worked with high-pressure or low-pressure steam; in the use of high-pressure blowing engines he had known some difficulty to be experienced in keeping up a regular blast, owing to the steam pressure being occasionally let down in the night; but a low-pressure engine was not liable to that objection. In the present case of a pair of engines blowing together, one might be worked high-pressure and the other condensing with the same steam, and saving a large proportion of the fuel.

Mr. COWPER replied that the engines had been designed specially for lightness, to meet the peculiarity of the situation for which they were intended, and they had therefore been made non-condensing, cutting off at half-stroke, with 50 lb. steam; but wherever the circumstances admitted of it, he would certainly make high-pressure expansive and condensing engines, so that great economy of fuel would be obtained.

Mr. SAMUEL LLOYD, jun., remarked that in the case of a single blowing engine the use of a fly-wheel was objected to, as it was then found that the blast was less steady than without the fly-wheel.

Mr. COWPER observed that this must necessarily be the case with a single engine, as the fly-wheel, by making the crank shaft revolve uniformly, caused the motion of the piston to be faster at the middle than at the ends of the stroke; but in the ordinary single engines without a fly-wheel, the motion of the piston was regulated by the resistance of the air, and consequently it remained much more uniform throughout the stroke, causing less fluctuation in the supply of air to the main. A fly-wheel was only applicable when two blowing engines were coupled at right angles to one another, but even then the full advantage of the engines being coupled could not be obtained except by a quick-stroke small engine, such as those described in the paper, where the intervals between the successive discharges of air into the main became so small (amounting to less than a quarter of a second) that no appreciable fluctuation of pressure was produced, although the ordinary regulator or reservoir was entirely dispensed with.

Mr. FAIRBAIRN observed that this regularity of the blast was a great advantage, and gave an important superiority over the ordinary engines; the same advantage would apply still more completely to the fan blast, if it were found capable of producing sufficient pressure, and he should be glad to know the exact particulars of its application to blowing furnaces.

Mr. SAMUEL LLOYD, jun., remarked that one difficulty in applying the fan to blowing furnaces would arise from the circumstance that it was sometimes requisite to employ a higher pressure and smaller tuyeres for a time, in order to clear the furnace when it had got out of order; this could be readily effected with blowing cylinders by increasing the steam pressure when required for that purpose.

Mr. COWPER said that a different treatment was requisite for blowing a blast furnace and for a cupola; for blowing a cupola experience had led him to prefer the fan to a cylinder blowing engine; he was aware that a heavier pressure had been advocated for the cupola, but he had found a large quantity of air blown through 10-inch tuyeres better for that purpose than a higher pressure with smaller tuyeres; but for blowing a blast furnace, he did not think the fan would give pressure enough to force air into the centre of the furnace at all. He remembered that a plan had been suggested by Mr. Buckle, at a former meeting of the Institution, for increasing the pressure of the fan blast, by using two or three fans, one blowing into the other, making them al push together, so as to increase the pressure successively, the last one only communicating with the furnace.

Mr. SAMPSON LLOYD remarked that the great improvement effected in the last few years in the quantity of iron obtained from blast furnaces was mainly attributable to the increased quantity of air blown into them: a few years ago, 40 tons of iron per week was the general yield of a furnace, but this was gradually increased up to 80 and 100 tons, and now 150 to 200 tons per week might be obtained from a single furnace, which was as much as was given by four or five furnaces formerly. He thought it would be impossible to force in the supply of air necessary to obtain this quantity of iron by means of the fan, and he understood it had been given up at the furnaces near Chesterfield that had been referred to.

Mr. CLIFT enquired what was the power of the pair of blowing engines described in the paper, and the quantity of air they would deliver.

Mr. COWPER replied that they were capable of working up to 34 indicated horse-power each, and delivering together 3600 cubic feet of air per minute, at a pressure of 4 lb. per square inch.

Mr. CLIFT remarked that it had been proposed to use Jones's Gas Exhauster as a blowing engine, using four of them together, working one into another, in order to get sufficient power; he was not aware that they had been so used in this country, but he believed they were employed to a considerable extent in Sweden, where they were driven by water. This machine was very simple and portable in construction, and he had found it work very satisfactorily in discharging gas; from an experiment that had been made with the exhauster, it appeared that a steam engine of 5 nominal horse-power would force 80,000 cubic feet per hour of coal gas, or about 1300 feet per minute.

Mr. COWPER said that he had obtained a pressure of 10 to 15 inches of water, or about ½ lb. per square inch, with a large fan blowing a cupola with two 10-inch tuyeres; but that 7½ inches (or about ¼ lb. per square inch) was what he had generally adopted for cupolas and smiths' fires.

Mr. W. A. ADAMS said that he had heard of a fan at Messrs. Cubitt's works, in London, running, he believed, at 2000 revolutions per minute, by which a considerably higher pressure than usual was obtained. A great pressure might be obtained by using three such fans combined, the one fan blowing into the aperture of the other; this plan had been tried by Mr. F. J. Bramwell, and found to answer, the pressure indicated by the last fan being nearly three times that of each separate fan.

Mr. HENRY MAUDSLAY said he had not seen the fan at Messrs. Cubitt's, but understood that a pressure of 16 inches of water was obtained with it; it was a Lloyd's silent fan, 3 feet diameter, and worked quite silently.

Mr. FAIRBAIRN observed that Schiele's fan, which was much used in Manchester, was also a noiseless fan; it was worked at a very high speed, making 2000 to 3000 revolutions per minute.

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INSTITUTION OF CIVIL ENGINEERS.

Jan. 22 & 29; *Feb.* 5 & 12.—ROBERT STEPHENSON, Esq., M.P., President, in the Chair.

These evenings were entirely devoted to the discussion of Mr. Robinson's Paper, "*On the Past and Present Condition of the River Thames.*" (See *Journal, ante* p. 60).

It was explained, that the object of the Paper was to direct attention to the present state of the river Thames, in order that by inducing members of the profession to examine it, some method might be devised for preventing the exposure of the mud-banks and shoals at low water, whereby the atmosphere was tainted and more danger was caused, than by the foulness of the water itself. The author had devised a plan which he proposed briefly to describe in the course of the discussion, but, in accordance with the regulations of the Institution, he had refrained from enlarging upon it in his Paper, which had been restricted to historical points connected with the river and its management.

His proposition was to construct a chain of locks across the river, just above London bridge, so as to use the piers of the bridge as portions of the masonry of the piers of the fifteen locks, which would afford a lineal water-way of 552 feet, instead of 692 feet, as at present. It was anticipated, that the equalization of the depth of the river would compensate for the width thus reduced. In all the lock-gates, which would be of iron, there would be ample sluice-gates to allow of the passage of the natural current of upland water, which alone would have to pass; the tidal water being entirely kept back. The lock-gates were proposed to be worked by hydraulic power, as were those of the Grimsby docks, and the new Victoria dock—and the cranes in so many docks, both in the metropolis and the provinces. It was proposed to maintain the water above the locks at a level of about 12 inches below that of ordinary spring tides, so as not to inconvenience the surface drainage of the low districts of the metropolis. The barges above bridge would be towed by small steam-tugs, by which means the cost of conveyance of goods would not be more expensive, and be much more expeditious and certain than by the present system.

This plan would not at all exclude, but rather facilitate, the conveyance of the sewage, by lateral tunnels, parallel with the river, to any distance that might be judged advisable; but it was considered that no sanitary objections would exist to the raising of the diluted sewage matter, by means of scoop-wheels and small engine power, placed at the mouth of each existing large sewer, and thus discharging it into the river, whence it would run off through the sluices, without the possibility of return. If it was decided to have a tunnel along each shore, intercepting the mouths of all the present sewers, both could be kept constantly flushed and cleansed by the head of water from above bridge.

The chief objection hitherto raised against the plan, was the reduction of the tidal capacity;—now the tidal capacity of the river, between the mouth and Gravesend, was stated to be 17,000 millions of cubic feet; that between Gravesend and London bridge was 4320 millions of cubic feet; making a total of 21,320 millions of cubic feet.

The whole tidal capacity of the river above bridge was 657 millions cubic feet; which, being diminished by the amount of the current still to pass off during ebb tide, = 108 millions cubic feet, leaving a total of 549 millions cubic feet to be deducted from the gross, was only about 2½ per cent.

It was argued, that the greatest effect of the stopping of the flood tide would not raise the general level of water below bridge more than 4 inches in the tide way. That the scour of the ebb would be maintained as before; as the tidal water would run up and down again, scouring just as formerly, at the latter part of the ebb, when it would be aided by the upland waters through the sluices. It was contended, that the obstruction of the piers of the bridges and the contractions and shoals in the river prevented the full advantage of the scour being felt.

With regard to floods, it was argued, that their advent was always foreseen, and could be provided for by opening the sluices, and even all the lock-gates if necessary.

The question of the present plans for intercepting sewers was entered upon, and it was contended, that even from the apparent distant point of their fall into the Thames, the sewage would return with the tide up into the heart of the metropolis, especially when aided by the frequent easterly winds, augmenting the fœtid banks and shoals, poisoning the air, and tending to induce the same kind of frightful effects of disease as were produced in Russia by the mud banks of the canals and rivers. The ravages of the cholera in Russia were graphically described, and the energetic aid of the civil engineers was invoked to co-operate in warding off similar visitations, the danger of which, it was argued, was imminent, if the present state of the river was allowed to continue much longer.

It was contended on the other hand, that the author of the paper had undervalued the difficulties of the plan he had proposed. The extreme rise and fall of spring tides amounted to at least 26 feet, and after a prevalence of north-west winds, the tide had ranged as much as 3 ft. 7 in. above Trinity standard of high water of spring tides. These observations could now be made with great accuracy since the new standard marks had been fixed by Mr. T. M. Smith, under the direction of Mr. Leach, by order of the Corporation of London. The various plans proposed for embanking the river through the metropolis showed that the necessity for some amelioration of the present state was universally felt; but it was doubted whether the plan of bodily damming back the whole stream of water and excluding the tidal water would not augment the accumulations above the locks, and create a deposit below, which would ruin the pool, silt up all the dock entrances, and do irreparable injury to the port of London.

An interesting review was given of the early history of the docks, and of the few attempts at embanking portions of the shores of the river, as also of the failures which had occurred, both in them and in the piers for the accommodation of steam-boat passengers.

It was contended, that the cost and inconvenience of constructing and upholding the proposed large intercepting sewers could be accurately ascertained, but that the expense of the proposed system of locks could no more be accurately foretold than the effects upon the river could be foreseen. That the effects of the exposure of mud-banks for a few hours during each tide could not be compared with those of the mud deposits in Russia, which were uncovered for months under great heat; and that the constant ebb and flow of the tide aided in causing a change in the temperature and in the current of the atmosphere, and was conducive to the health of the metropolis.

It was admitted that the narrative in the Paper was substantially correct, and it was an undeniable fact, that the Thames was now in a disgraceful and dangerous state; yet the inference as to the effects arising from the tidal ebb and flow, and consequent exposure of the mud-banks, could not be admitted. During the period of the raging of cholera in 1832, the deaths in the city of London, situated on a tidal river, were 300,—equal to one in 400; those at Paris, on a continuous stream, were 18,000,—equal to one in 51; and those at Newburn, situated on the banks of a rapid mountain stream, were 62,—equal to one in 10 of the population. Thus the tidal character of the river, if it had had any influence on the origin or spread of the cholera, which was not admitted, it might be said to have produced a favourable result at the period alluded to.

It has been shown by the official engineers, and corroborated by eminent consulting engineers, that efficient intercepting sewers could be constructed, at a cost of 3,000,000*l.*, to convey the sewage of the metropolis to a point so low down the river as to preclude the chance of its returning with the flowing tide; therefore this might be accepted as a fact. One of the fallacies of the Paper was the assumption of the inability or the unwillingness of the inhabitants of the metropolis to find such a sum as 3,000,000*l.* for restoring to a satisfactory state their excellent river, when it could be done by an annual rate of threepence in the pound on the rateable value of the fixed property of the metropolis, taken at 12,000,000*l.* per annum, or a little more than one farthing in the pound on the annual income of the 2,500,000 inhabitants, which had been estimated at 100,000,000*l.*;—a threepenny rate on rateable property would pay 4*l.* per cent. interest on the capital, and extinguish the principal in forty years; without taking into account any return for the produce of the sewerage, and without calculating upon any augmentation of the population and property of the metropolis, although they did, in point of fact, increase 15 per cent. in every succeeding cycle of ten years.

The real cause of failure in the various plans that had been proposed for doing away with the pollution of the Thames and for improving the sewerage of the metropolis, during the last few years, was to be sought in the dissensions and divisions among the Commissioners of the successive Boards of Sewers. The fierce conflict between the advocates of the "big sewer" and the "little pipe" systems, emulating Gulliver's controversy between the "big Endiens" and the "little Endiens," although at first amusing to the spectators, had become serious in retarding progress, and had prevented the adequate use of material which, if properly employed, was calculated to be an important agent in a great improvement, for the benefit of the public, whose health and comfort were dependent upon the promptitude and vigour of the operations of sewerage.

It was encumbent on the new boards, both District and Metropolitan, firmly established as they were by act of parliament, to resist the mischievous interference of even government authorities, and to avoid being influenced by persons who might renew a struggle to maintain the ascendancy of certain dogmas, whether resulting from honest but mistaken prejudice, or from personal and interested objects. If the government wished to encourage a full discussion of the state of the Thames, there was ample field for it in parliament, in the Metropolitan and District Boards of Works, and in the various scientific societies. The basis being once settled, not by an official note at the suggestion of irresponsible and ignorant persons, but after due and adequate consideration, the Metropolitan Board should learn, from the example of their predecessors, to avoid waste of time in useless discussions, and to apply their energies to the execution of plans that might be approved. If such were not the case, the representatives would be changed by their constituents until they did understand and perform their duty fearlessly and well. The public always had provided and would still find the funds for any manifest improvement, and none could be greater than restoring the Thames to its normal condition.

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It was contended, that the conversion of the Thames into a partially stagnant "cloaca" and canal, could not be executed with anything like the assumed facility, or within an adequate sum; even if the expediency of the plan, and the efficiency of the system of raising the sewage by mechanical means, could be admitted;—nearly the whole of the wharf property on the sides of the river would require re-arrangement, and numerous modifications must be made which would demand a very large extra outlay, not contemplated in the plan laid before the Institution, and the commercial uses of the river would be subjected to great and inconvenient changes, all of which should be well provided for.

If the members of the Institution would unanimously insist upon the impropriety of permitting any sewage matter to be poured into the Thames within a certain distance of the metropolis, the calm but confident expression of their opinion would carry conviction to the minds of the public. Let the true, scientific, and practical principles be so settled, and the public would readily supply the means for execution. The people did not like filth and would not tolerate it in any form, nor did they like having the tax-collector's hand in their pockets too frequently, but for the sake of cleanly homes and wholesome air they would pay handsomely, provided the matter did not savour of a job.

The next considerations were,—to whom did the river belong, and who was to blame for its present condition? As to the first point,—though it might be necessary to have some more litigation to ascertain with the legal precision usual in such matters, who was the owner of the Thames, still it was contended that the evidence was pretty clear, and on it, as well as on the second point, if Old Father Thames could be interrogated he would say, that though occurrences of upwards of a thousand years past were somewhat misty, his recollections were not quite obscured, and he would recall the time when the Romans under Maximus and Theodosius, aided by the tribute of the city of London, then a Roman municipium, embanked the river which divided the two great provinces, Britannia Prima and Flavia Cæsariensis. The government of the port and river remained under the municipal government of the Londoners until the Romans retired from the kingdom, and it was afterwards retained by the citizens, as the boundary separating the Angles, who were settled north of the Thames as far as Caithness, and the Saxons who held the country south of the line of the river.

During the Heptarchy the Corporation governed the Thames, and Edward the Confessor established courts of conservancy with ample powers secured by charter to the aldermen of London, whose station was recognised even before the kings of England had being.

William the Conqueror at his advent exhibited considerable shrewdness, in wishing to take possession of the river, but the Corporation evinced so determined an opposition that, desiring to be considered "friendly" as he termed it, he granted a short but comprehensive charter confirming, in general words, all the privileges granted by Edward the Confessor. This charter, very unlike the diplomatic notes, protocols, treaties, &c., of the present day, consisted of only a few lines, but although after an interval of eight hundred years its phraseology might appear somewhat obscure, it was at the time capable of being comprehended by the meanest capacity, and completely to the purpose.

Many of the succeeding kings attempted to interfere with the government of the river, but invariably met with the same successful rebuffs from the citizens.

Favourites and courtiers, then as now the fruitful sources of all evil, were equally unsuccessful in enforcing the grants illegally made to them; until at length in the reign of James I., the citizens actually filed an information against the Crown to establish their rights, and Sir Edward Coke the attorney-general, confessing the right of the Corporation based upon immemorial usage, judgment was entered up in the Court of Exchequer; but to make assurance doubly sure, the king recognised the right and confirmed it by a charter, which though annulled by *Quo warranto* in the Star Chamber, was confirmed with the other charters granted to the city by William III., whose plain common sense and feeling of justice recognised the evident rights of the Corporation to continue to be the conservators of the river which had been so long in their hands, and had been by them so ably administered.

It might have been supposed that there could have been little or nothing to quibble about in so plain a position; but great was the complexity of the law, and still greater the ingenuity of legal men and courtly advisers. Possession of a property for a certain term was always assumed to confer rights of ownership, unless better rights to possession could be shown; in this case, however, the Crown laying claim under its royal prerogative, to the beds and banks of rivers, and the shores of the sea between high and low water, called upon the Corporation to prove its right to the conservancy and soil of the river. The citizens naturally resisted so monstrous a claim; they asked to have the question tried by the short and inexpensive process of the Common Law Courts, but were introduced to the Lord Chancellor, before whom, during the last twelve years, there had been already executed more parallels, zig-zags, and other tortuous approaches and exhibitions of strategy than before Sevastopol, without ever yet arriving at the stage of examining a single witness, or ascertaining one solitary fact.

In consequence of the removal of the old bridge in 1832, shoals were thrown up in various parts of the river, whilst the action of steamers on the water undermined the banks, and constantly stirred up the deposited impurities. The Corporation, anxious to redress these injuries and to prevent their growth, appointed a commission to examine the river and to report what measures could be taken for the purpose. The commission consisted of Mr. James Walker, then the President of the Institution, Captain Bullock, R.N., Hydrographer to the Admiralty, and the officers of the Thames Navigation and Harbour Services. The Report recommended the Corporation to remove certain specified shoals at a cost of 60,000*l.*—and also:

1st. To give encouragement to frontagers wanting more wharf room, from time to time, to embank to a line set out on the plan; thus correcting existing irregularities on the banks, and eventually approximating to one uniform line.

2nd. To encourage frontagers not wanting more wharf room, but requiring space for barges or timber, to secure for their own use, by dwarf piling, the space lying between the plan line and the river frontage.

3rd. To charge a reasonable sum to the frontagers for the use of the ground appropriated by them, whether embanked or piled: the sum to be fixed by arbitrators, who were to determine the value by considering the worth of the ground appropriated, and the cost of reclaiming it.

4th. To secure by dwarf piling the channel of the river as laid down on the plan, on those parts where the frontagers did not require the use of the increased embankment or shore.

5th. To remove shoals and to excavate the bed of the river to a suitable depth, between the lines laid down on the plan by the engineers.

6th. To erect secure and convenient steam-boat piers, in convenient places on both sides of the river.

7th. To dedicate the money produce of the embankment and steam-boat piers towards the improvement of the river.

The Corporation adopted the recommendation in the report, commenced the removal of one of the shoals, and granted licenses to the late Mr. Cubitt and others to secure their property and improve the river by embankments, several miles of which were made at Battersea, Pimlico, the Isle of Dogs, and other parts.

The Corporation proposed to place the whole management of the river in a smaller committee of their own body, under the control of an act of parliament, and to borrow upon their own landed property 300,000*l.* to aid the execution of the plan.

This noble design had, however, been put in suspense by the Crown lawyers, who had filed an information and obtained an injunction to stop the works. They sought to wrest the right to the soil of the river from the Corporation, and claimed to have the improvement fund as part of the hereditary revenues of the Crown, to be applied to the private uses of the sovereign, instead of appropriating the whole fund, as the Corporation proposed, to the improvement of the river. The Corporation had strenuously resisted this, and the suit had been pending twelve years, during which time the river had been suffering from the want of that vigorous treatment which the Corporation were disposed, under the advice of the engineers, to have applied to it out of their own funds.

If the plan recommended by Mr. Walker and his colleagues was not a proper remedy for existing evils, a better system should be sought for at the hands of competent advisers, and it ought to be carried out by the Corporation or the Crown, or some other authority; but the Corporation could not be expected to expend any more money in the state of uncertainty created by the chancery suit. They had already indorsed the bonds of the navigation fund to the extent of 150,000*l.*, the interest of which a falling revenue was not now sufficient to pay; besides which, the Corporation had advanced above 60,000*l.* in removing shoals and other improvements, even whilst they were compelled to waste a large sum annually in law costs.

It was difficult to conceive how any objections could be raised to a plan so evidently for the improvement of the river and the benefit of the metropolis, without adding to the funds or the patronage of the Corporation. Yet there was every appearance of the suit being interminable, because in reality the question did not relate to the Thames alone. If the claim of the Crown could be successfully maintained, it would enable the royal prerogative to take possession, as its apanage, of the shores of Birkenhead and elsewhere, and then, at the commencement of some new reign, the Crown might say that such acquired demesnes, in addition to the woods and forests and other acknowledged hereditary revenues of the crown, were preferable to the civil list granted by the representatives of the nation for the support of the sovereign. This then was only the thin end of the wedge, and it was encumbent on all to aid in resisting such unjust claims.

While this apparently interminable suit was pending, it was admitted that the bed of Father Thames was being neglected and polluted, and it was urged, that instead of becoming agitators against the Thames as a tidal river, and exaggerating the apprehensions of cholera on that account, the members of the Institution might do good service by considering the case, devising sound principles of action, leading to good and useful results, and enforcing upon the public, with all their power and influence, the necessity for and capability of improvement of the noble river in conjunction with effectual means of intercepting the sewage which now polluted its once pure and pellucid stream.

It was contended, that the health of the inhabitants should not be

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endangered, on account of the conflicting claims of the government and of the Corporation, to the rights of administration, or of dealing with certain powers, by which alone a great benefit could be conferred upon, or withheld from the metropolis; for there could be little doubt of the miasmatic vapours, arising from the impurities held in supension by, or deposited upon the mud banks, by the waters of the Thames augmenting the spread of disease. It was, therefore, incumbent upon the contending parties, rather to combine their forces for the execution of the works of improvement for the common-weal.

Ague was formerly the prevalent disease; but the drainage of the land of the marshy districts near the river, almost obliterated that malady; then followed fevers of various kinds; but they were diminished, or prevented, by abolishing cesspools beneath the houses, and by more rigid attention to house sewerage; then came cholera, the recurrence of which would doubtless be in some degree counteracted, by ameliorating the state of the banks and shoals of the river, to whose noxious vapours much of the disease of the metropolis must be attributed, when it was considered how many millions of gallons of vapour were given off per day from the river alone. It had been stated, that the mortality was three times as great on some parts of the coast and on the shores of muddy rivers, as in the inland districts; and there could be little doubt that there would be a great accession of disease, but for the constant ebb and flow of the tide. It was therefore much to be doubted, whether any plan, by which that incessant change in the water of the river would be to some extent arrested, would be beneficial to the general health of the metropolis.

The plan should receive careful consideration, in order to weigh the anticipated objections against the proposed advantages. Huddart, Mylne, Telford, Rennie and others had studied the question deeply, and arguing from the effect produced by somewhat similar works, on smaller rivers, they entertained serious doubts as to the effect of arresting the freedom of the flow of tidal water up any great estuary or river. It was stated, that the ebb tide now acted longer than before the removal of old London-bridge; and if the flow occupied five hours, and the ebb continued during seven hours, it appeared contrary to reason to assert that the sewage was not carried downwards more rapidly than had been stated, or than it would be by the action of the current of the stream of upland water alone, without the aid of the tidal water. It was found at Lynn that the scouring power of the ebb had been greatly augmented by the freer admission of the tidal water. It must be recollected, also, that nearly all the water for domestic purposes in the metropolis, was now taken from points in the Thames above the influence of the tide, and would soon be returned to the river far below the eastern part of the city; therefore, it became incumbent to provide for this deficiency, by the freer admission of the tidal water, to scour and carry away the inevitable deposit from waters flowing through alluvial districts; and, at the same time there must be a certain change of the atmosphere induced at each ebb and flow of the tide.

There could be little doubt also of the advantages to be derived from such shore works, as would give to the bed of the river an uniform capacity. The propositions of Wren, Rennie, Mylne, Wyatt, Trench, Martin, Walker, and Page, all had that object in view, and it was most desirable, that the government and the city should settle their differences, in order to the execution of some definite and comprehensive plan.

Recurring to the plan proposed in the Paper, it was contended, that even if the sewage could all be raised by mechanical means and be poured into the river above the locks, where the current would, during the whole of the flood tide, be consequently sluggish, a much greater deposit would occur than at present, and the duration of the ebb would not be sufficient to dislodge it and to convey it away through the sluices; whilst below the locks in the heart of the most densely populated part of the metropolis, all the impurities whether poured from the upper portion of the river, or brought up by the tidal flow, would be arrested in the pool, causing a great deposit against the lower side of the dam, in all the entrances of the docks, in the numerous creeks, and in every position where the water became even partially stagnant.

It was contended, that the scheme of raising the sewage from the mouths of the present sewers would be so expensive as to amount to a prohibition, especially if such power was provided as to enable all the storm waters to be raised. Besides, if the sewage was all dammed back to the extent that would be necessary for such a system, large portions of Lambeth and of Westminister would be rendered uninhabitable. It was to be apprehended, that if the sewage was poured into the river, only such a portion of the upland water would flow through the sluices, as would leave the heavier matter deposited in the bed of the river, which would become worse than at present.

There was not any analogy between the Thames and the Neva; the former received all the sewage of London, whilst at St Petersburgh, cesspools were generally used, the contents of which were removed by manual labour, as at Paris, and chiefly during the winter, when the operation was almost innocuous.

It must be recollected, that the sewage from 20,000 houses was now conveyed to the river, and in the ratio of the improvement of the habitations had been the pollution of the stream. If the sewage could be concentrated and poured into the river above Teddington lock, some opinion might be formed of what would be the effect of the plan proposed in the Paper. The general voice of the public guided by the opinion of eminent professional men, had declared for the execution of the scheme of intercepting sewers, conveying the sewage of the metropolis to a certain distance down the river, and if that distance was found to be insufficient, it must be carried still lower. The public, who had objected to one or two pumping establishments for sewage, far down the river, would certainly protest loudly against setting up a number of such machines in the midst of their habitations; and if it was intended to provide for raising the storm waters, the number of pumping stations would necessarily be very great, as there would not be any means of allowing the water to run off by gravitation, which was evidently the most common sense, as well as the most economical system.

The proposed series of locks would form a dam to keep in the upland water and to restrain the ascent of the tidal waters, even during high tides, which at times reached as much as 4 feet above Trinity high water mark; enormous tumbling bays must therefore be provided with substantial aprons below them, to prevent the degradation of the work and the destructive effect upon the bed of the river; and this in a position where the width was now only sufficient for the body of water brought up by the flow of the tide. The upward passage of barges both below and above the locks, must be accomplished by steam tugs, as there would not be any assistance from the tide; the pool below being rendered nearly stagnant; and the rise being only vertical. The expense of these works would be enormous; besides which, by the alteration of the standing level of the water in the upper part, the level of saturation of the strata of all the adjacent district would be raised, to the evident detriment of the property, upon which large sums had been expended for obtaining efficient drainage. In fact this scheme must be looked upon with as great mistrust as the untenable proposition of obtaining a maximum flow of water through pipes of a minimum sectional area.

It was asserted that the deposit of mud in the bed of the river, was actually diminishing, and that on many gravel shoals there was not a greater thickness of silt than 2 inches; but there was now a decided disposition to silt up many of the creeks, dock entrances, floats, &c., where the deposit had been observed to take place at the rate of nearly 6 inches per annum. The bad state of the water in the Thames, during the past year, had been to some extent caused by the extraordinary drought of the two preceding years, and when Dr. Faraday wrote the often quoted letter on the subject, he omitted to state that he had examined the water just at the period of an extraordinarily low neap-tide, when very little tidal water came up, and when there was stated to be a decided diminution of the "perennial flow" of water from the strata through which the Thames flowed.

The maintenance of the oscillation of the tide, up to the highest possible point, was contended to be very essential to the good condition of the river. It had now been determined, that in rebuilding the lock at Teddington, the cill should be laid 8 feet deeper than at present, and that the bed of the stream should be dredged out, to correspond with that level; this would render material assistance to the scour, as the tidal flow would be increased. It was submitted, that the ebb and flow must have considerable influence upon the sanitary condition of the metropolis, as twice in each day, of twenty-four hours, the whole atmosphere over the river was lifted up the full height of the tide on flow, and again lowered on the ebb, which alone must cause considerable change of the air. If so much 'malaria' arose from the mud banks, how was it that the men who worked constantly on the wharfs and on the steamboat piers, even at Blackfriars-bridge, close to the outfall of the Fleet ditch sewer, did not exhibit a more than average mortality?

It was contended, that this assumed change of the atmosphere by the rise and fall of the tide, was not clearly demonstrated; experiments had not shown that there was any corresponding current of air, close to the surface, either during the ebb or the flow.

Attention was directed to the statement of danger being apprehended from the failure of the large intercepting sewers. Now, the largest sewer that was contemplated was only 10 feet in diameter, and the permanence of the railway works of much more importance as to size, and presenting much greater difficulties in execution than any sewer in London, demonstrated that the engineers were fully capable of constructing a sewer of 10 feet diameter, and insuring a successful result. The necessity for the large size of that sewer had been contested, but it must be recollected that the metropolis was increasing and extending in a wonderful manner, and it might be anticipated that, in a few years, other additional intercepting sewers would be required; indeed it was a question, whether it would not be less expensive to construct one new intercepting sewer for an extensive outlying district, rather than to form a large number of small branches falling into the main conduit. The plan proposed in the Paper had been virtually tried on many streams, where old mills had been permitted to establish weirs across rivers; and in all these situations it was now found necessary to form intercepting sewers, for the lower drainage, having their outfalls below the mill-dams.

The system of intercepting or catchwater drains for land drainage had long been applied by Smeaton, Rennie, and others in the Fens, and the applicability of the system to town drainage was so evident that it was now generally adopted by all sound practitioners.

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It was explained that the great increase in the tidal range, between London docks and Teddington, averaged in the years 1823 and 1845 2 ft. 7 in. increase of fall, and 1 foot increase of rise at Battersea; other places being similarly affected by the removal of obstructions in the river. The removal of old London-bridge alone increased the area, at high water, from 7300 square feet to 17,600 square feet; and the spring-tide range from 16 ft. 9 in. to 19 ft. 9 in.; a process diametrically the reverse of that proposed in the Paper.

From a comparison of tidal observations taken at Lambeth Reach, it appeared that—

	A.D. 1720.	A.D. 1849.
The duration of Floodtide at Springs, was	$3^h\ 50^m$	... $5^h\ 15^m$
,, Ebb ,, ,, ...	8 40	... 7 5
,, Floodtide at "Neaps"	4 50	... 6 00
,, Ebb ,, ...	7 35	... 6 23

Showing, of course, a proportional increase of scour and difficulty of deposition on the banks when united with the foregoing fact, that a very large increase of volume at every tide, accompanied those changes of time. Accordingly, the tidal velocities at spring tides, before and after the removal of London bridge, appear to have been;—

	First of Flood. Feet per minute		Last of Ebb. Feet per minute	
	1831.	1833.	1331.	1833.
Between Southwark and Blackfriars ...	158	174 ...	252	295
,, Blackfriars and Waterloo.....	149	173 ...	196	239
,, Waterloo and Westminster ...	140	150 ...	169	191
Mean...	149	166 ...	206	242

It had been frequently assumed by the public, that the Institution pronounced a collective opinion on subjects submitted to the meetings; such, however, was not the case, and all that was said in the course of the discusions must be received only as the individual opinions of the several speakers. These were, in some cases, very valuable, and it was probable that if an engineer had to work out the details of a design, after it had undergone the ordeal of discussion, his views would be materially modified; this was one of the great benefits of the Society.

In the plan now laid before the meeting, two prominent points were to be considered:—1st, the mode of providing for the sewage of the metropolis; and 2nd, the method of dealing with the river, as it would probably be affected by the proposed construction at London-bridge.

As to the first position, it was not contended, that treating the sewage was an inherent part of the plan—indeed, it would be better to leave the sewage to flow through the new intercepting sewers, as proposed by the engineers to the Commission. Or it was practicable to construct an intercepting sewer on each side of the river, into which all the present sewers would fall, and the contents would be delivered at a low point in the river, or used for agricultural purposes, as might be found advisable. At all events, it was better not to pour the sewage into the upper part of the river, under any circumstances.

As to the second point. The effect upon the river must be considered above and below bridge; above the locks, there would be a comparatively stagnant pool of water, perhaps, partially purified, therefore some of the advantages claimed by the author might be admitted; but there were many and severe counterbalancing disadvantages;—such as the deposit of silt, not, however, to the extent contemplated by other speakers, or else the river above Teddington would have suffered in a similar manner, and many rivers in England would have been seriously affected. The other obvious objections would be;—the loss of the convenient and economical power of the tide;—the hindrance to steamers;—the interruption from ice;—the inconvenience to the traffic, from the passage through the locks; and the infiltration of moisture into the strata around.

The great question was the effect below bridge; the Thames was now in a good state in some respects, the removal of old London-bridge, and various shoals and rocks, had increased the scouring effect and had deepened the channel, and more might still be done. The effect of the lock and dam on the Witham, at Boston, was quoted as an example of what could be done by this kind of work. In 1766 a sloop of 50 tons could scarcely reach Boston; whereas now, by proper arrangement of the width of the stream, the channel had been deepened, and vessels of considerable burthen now reached that town. So with the Thames; the greatest care should be devoted to the training of the channel; either with or without the proposed locks, and the anticipated silting would be prevented; the free inflow of the tidal water should be encouraged, and the sectional area be maintained. It might be anticipated that the scour from the sluices would create a shoal, at no great distance below the locks, and this was of such importance as alone to almost preclude the trial of any such plan.

It must be admitted, that the Paper which had originated this discussion, although it had proposed a plan which was generally opposed, was not only intrinsically valuable, as assembling and recording many curious historical facts relating to the river Thames, but it was suggestive of numerous topics of great interest, and had induced an address, remarkable not only for the humour and vivacity with which the statement had been given, of the long and close intercourse between the Corporation and the river, and the litigation now induced by the pretensions of the government, but which had even raised from his bed the venerable genius of the stream, and induced him to unveil his griefs. It was, however, doubted whether the confidence had been fully given, —whether, in these conversations, which had probably taken place in the "cool tranquility of dewy eve," and under the genial influence of City hospitality, Old Father Thames had not made some remonstrance, in a tone of complaint, of sundry negligences on the part of his old friends; of the utter neglect of the grand plan of Sir Christopher Wren; —the entire disregard of architectural propriety, or of uniformity of line, exhibited by the warehouses and wharfs;—vast shoals and mud-banks on all sides;—several of the bridges in a state of jeopardy;—and that dire foe "vested interest" allowed to rise up as a lion in the path, barring all improvement. The Corporation had only themselves to blame for all this; but as it appeared that there was such confidential communication between that plain spoken old gentleman Father Thames, and the worthy energetic legal representative of the Corporation, it was to be hoped that, henceforth, all good plans for amelioration would receive active support and assistance in the City. For instance, that concessions would be granted, by the Corporation, to persons desirous of improving their water-side premises, merely on the production and approval of their plans; instead of obliging them, as at present, to obtain the sanction of their neighbours, which was virtually a prohibition; because every man knew that he would be obliged to follow the example of his more energetic neighbour, or he would soon find his premises at the bottom of a mud-trap, and out of the reach of the river.

The complaints against government interference were but too well founded, as was unfortunately felt by all who had bills before the House, for any works on the banks of the Thames. The Bill might go on very smoothly until the third reading, when a sleek gentleman made his appearance with an application, merely for the insertion of a little clause for the protection of the rights of the Crown; which meant, that all plans should be submitted to, and be approved by, various heads of "Circumlocution" offices; the inevitable result being that, the unlucky wight, seeking to have his plans approved, wasted his time, and then had to pay a good round sum for some imaginary right supposed to be conceded to him, for doing something which could be of no earthly use to him, or for proceeding, without let or hindrance, to some place, whither he had no intention of or interest in going. Now, if he was thus mulcted for the welfare of the nation, or the benefit of our sovereign lady the queen, no one would grumble very much; but when it was known that the plunder so obtained, only went to fatten those detestable reptiles "the red tape worms," the matter was beyond endurance.

Reverting to the Paper which had caused these remarks, it would have been easy to have introduced into the discussion, the effects of the scour of tidal waters, and the changes induced by modifications of the form of estuaries and rivers; but they would be better reserved for a future occasion, when on the discussion of a Paper promised by a member, it would be necessary to review the proceedings of 'the Little Admiralty,'—that 'imperium in imperio,' by which works of vast importance were unjustly and unnecessarily restricted, to the detriment of the property and the injury of the sanitary condition of the country.

As to the question of the system of sewerage about to be carried into effect for the metropolis, ample opportunity would be afforded for discussing it in detail, on the reading of a Paper, promised by a member eminently qualified for the task, and from whom the plain truth would be obtained, when a vindication would be given of the views and investigations of those ancient philosophers, who had no party purposes to serve,—no pot-pipes to sell,—nor any petty malice to gratify. The meeting had already heard the apt comparison of the onslaught of the theoretical little pot-pipes upon the common-sense, practical, large, and adequate brick sewers, to the immortal strife of Gulliver's "big Endians and little Endians," and, doubtless, the whole affair had been very exciting and pleasant to the amateur performers in the comedy, but it would be found to be an expensive kind of amusement for the rate-payers; and when disease again made its appearance, and found the metropolis still unprepared, who could predict the direful consequences. It was hoped that the present Metropolitan Commissioners, who had hitherto exhibited excellent common-sense in their proceedings, and in the nomination of their officers, would avoid the rocks upon which their predecessors had split; would resist the mischievous interference of amateurs, of government nominees, or of any persons interested in maintaining the ascendancy of any peculiar dogmas, or in the introduction or the employment of any peculiar "material."

As to the effect of the exclusion of the tidal water from above bridge, if it was shown that the effect of the removal of old London-bridge had sufficed to excavate the channel, and to lower the ebb nearly 5 feet in about thirty years, it was fair to argue that if that impediment to the free flow of the tide had never been created, the bed of the Thames would have been down at its original level,—that at which the relics of previous ages of inhabitants were now found; and also that the construction of a more considerable impediment would have a still more pernicious effect upon the river.

Those who had visited Norway could form a good opinion as to the state above bridge, if the sewage was poured into a semi-stagnant pool. At Christiania, the water in the natural harbour or "fiord" was very

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deep, the rocky sides were nearly vertical, and the river running into it was a mountain stream; but during the summer months the noxious gases could be seen bubbling up from the stagnant muddy deposits, and the stench was unbearable. The deaths from cholera in that locality, were for a time about 500 per week—out of a population of 40,000 persons—a ratio which if applied to London, would be about equal to 30,000 per week. Cholera appeared to attach itself to classes as much as to localities, and the habits of the labourers on the river and of the inhabitants of its vicinity rendered them peculiarly susceptible of that kind of disease. In an important insurance office, where the lives were well selected, there had been only one loss from cholera.

The state to which the lower part of the river would be reduced by the construction of the proposed dam, would be fearful, and precisely in the portion of the city where the population was most densely crowded; and it would be difficult to predict where the consequences would stop.

If land and house drainage were generally beneficial to the health of communities, herding together in cities and towns, it must evidently be desirable to scour out the channel of the river, serving as the main land-drain, and as the eventual receptacle for the house sewage. Experience had shown that this could only be accomplished by the free and copious admission of the tidal water, to act powerfully on the ebb, which could scarcely fall too low; just as the flow could not rise too high, or extend too far. Even if Teddington lock was removed upwards, to some position nearer to Hampton, and the river thoroughly trained to receive the tidal flow, the effects would be beneficial throughout.

At present the steamboats constantly agitated the deposit on the banks, and if there was a copious and long ebb, considerable quantities of the mud would be carried away. If, however, the upper Reach of the river was converted into a partially stagnant pool, that effect would be counteracted, and accumulation would commence, which would end by reducing the Thames to the same condition as the Po, and other rivers, whose beds were now considerably above the land adjoining them. The time required for passing the traffic of the Thames through the locks would act as a serious impediment to commerce, particularly as the barges generally came up through the pool in fleets with the flowing tide.

The passenger steamers which now afforded the greatest relief to the over-crowded thoroughfares of the metropolis, would be injuriously arrested by the obligation for transhipping their passengers at the locks, as it would never do to let them pass through, taking their turn with the barges.

The case of the river Clyde, at Glasgow, should be carefully examined when considering any measure for the *regime* of the Thames. The Clyde had become a vast tidal canal, only kept open by a constant dredging at great cost; it would evidently be very objectionable to reduce the Thames to a similar condition. It must be concluded that the plan proposed in the Paper was not tenable either in a commercial, a sanitary, or an engineering point of view.

It was contended in reply that no injury would be done by occasional excessive tides; because the dam might be so constructed as not to diminish the water-way through the bridge, and if it were not found possible to save the lower district from being flooded, if such tides were dammed out, the gates could on any emergency be opened, and a passage given to the same quantity of water as at present; it was no proof that the sewage would be always travelling downwards, because a float would be a certain distance lower at each successive tide; the cases were not analogous, because the sewage was always rapidly mixing with the water around, and this mixing was accelerated by the tide running up at the sides, whilst it was still running down in the middle; by every easterly wind causing an upward surface current against the tide; and by the wave carried by every steamer. It was asserted that sewage was accumulating and mounting the river, as was shown by the water being now foul at Richmond, although it was pure a few years ago at Putney; and it was considered that the tidal action could never stop and remove an evil, of which it had not been able to prevent the increase; the mud-banks were admitted to be shifting in some places, owing to the scour which the removal of old London-bridge had caused, but that this effect would cease when the channel had been thus sufficiently deepened.

It was stated that sewage matter was nearly all soluble, and it was proposed that it should always be running away and not be pounded up, as has been erroneously imagined. No fear was entertained of its settling or even remaining in the river, as the actual solid matter would be about 30 tons per day falling into 20 millions of tons of pure water. It was urged that the amount to be raised had been much exaggerated; it was deduced from a report to the Commissioners of Sewers that the low level sewers, from which alone the sewage was proposed to be pumped up, discharged a maximum of 18,000 cubic feet per minute, and this amount was stated to require 10 pumping stations on each side of the river, with an aggregate horse-power of 300 horses. It was urged that the loss of the propelling power of the flood-tide was a commercial question, and a statement was given, from observation, to show that the amount of traffic was now comparatively small.

With regard to the engineering features of the case, it was stated that the principles laid down by the great authorities were not in any way questioned; the tendency in the upper part of the river to silt up was admitted; but it was argued that the absence of the material would prevent that effect being produced, as anything passing at Teddington would soon settle, and could be easily removed, the banks or bottom would no longer be carried down by the slow current, and when much was brought in by drainage after rains the same cause would give the velocity of current required for removing it; it appeared to be conceded that there would be no danger of an additional rise of tide below bridge, and no speaker had apparently anticipated danger to the mouth of the river from the small reduction of tidal current; it was urged that little danger existed of injury to the pool, both on account of the comparative purity of the water and from the artificial scour of the stream issuing from the dam; that the value of a scour was only great at or near low tide, when the same amount would pass as at present, but which amount could be doubled, if required, for the last hour of the ebb; the question of the future drainage of the low-lands was also met, and it was contended that as it was proposed to maintain the water level below the surface of the ground, instead of permitting it to rise above as at present, and to dam out the frequent extra-high tides which flooded those districts, real good would be effected in this respect.

The views of the author were admitted to have been somewhat modified by the deliberate opinions of so many of the older members, and if he ventured to retain faith in the efficacy of the proposed plan, it was because full weight had not been given to various modifying circumstances peculiar to the case. The subject was undoubtedly one of the most interesting which could come under discussion; it was hoped that a candid consideration would be given to the arguments adduced in favour of the plan, and it was felt that the result would be the conviction, that though the views might not be at once admitted, yet there were at least two sides to this important question.

It was admitted that the author's reply had done great credit both to his head and heart; and if he had not met with many supporters, he must have made friends by the openness of his statements, and the straightforward manner with which he had met and argued all the contested points during the protracted and interesting discussion.

Feb. 19 and 26.—A communication was made by Mr. G. P. Bidder, on "Mental Calculation" which we are compelled to postpone, owing to the length to which the discussion upon the condition of the Thames has extended.

ROYAL INSTITUTE OF BRITISH ARCHITECTS.

Award of Premiums.

At a special general meeting of the Institute, held on Monday evening, February 18th.

The royal gold medal was unanimously awarded, subject to her Majesty's gracious approval, to William Tite, Fellow, F.R.S., M.P.

The Soane medallion was awarded to Mr. Leonard R. Roberts, of Sackville-street, Piccadilly, for his design for a town mansion.

A medal of merit was awarded to Mr. Thomas C. Sorby, of Guildford-street, Russell-square, for his design for Law Courts.

A medal of merit to Mr. James Blake, of Handsworth, Birmingham, for his design for a town mansion.

And the silver medal of the Institute to Mr. T. A. Britton, of Camden-town, for an essay on "The Timber growing countries of Europe and America."

The students' prize in books for monthly sketches was awarded to Mr. C. N. Beazley.

The subjects for competition for the current year were announced. Among them are a metropolitan hotel, and illustrations of mediæval buildings in Ireland and Scotland, hitherto unpublished, with descriptive particulars.

NEW DRAWING MACHINE.

At Devon Great Consols Mines, a large party of agents and others connected with mining adventure, attended to witness the setting to work of a new arrangement of mechanism, intended for drawing in situations where the water-wheel is situate at a distance from the shaft. The agents having long found the use of a horse-whim most expensive and objectionable, devised many means without success (the shaft being 1200 feet from the water-wheel), and it was reserved for Mr. Vigus, a carpenter in the neighbourhood of Tavistock, to surmount the difficulty.

He takes the basis of his motion from the reciprocating action of the pump rods, at the top of which is a rack, which takes into a corresponding cogged periphery of a hollow wheel, which, of course, partakes of a similar motion. Inside this is another wheel, provided also with a rack, into which a clack in the outer wheel falls, and gives the inner wheel a continuous rotary motion. On the shaft of this is the drum, round which the rope is wound, and fifteen kibbles are now being drawn per hour by it at little expense. The invention appears to have been completely successful.

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ROYAL SCOTTISH SOCIETY OF ARTS.

"Application of the Altitude and Azimuth Circle to Stereometric Surveying." By EDWARD SANG.—After adverting to the many advantages which the altitude and azimuth circle possesses over the theodolite as a surveying instrument, Mr. Sang described the peculiar process, which formed the subject of his paper, to consist in observing, along with the bearing of a tall signal-staff, the nadir distances of two marks made near the two extremities of the staff: the data thus obtained furnish the means of readily computing the place of the signal-staff upon the plan, and also its altitude above the sea or above any known level.

"On an Isolating Atmospheric Gaswork Condenser." By JOHN YOUNG, Dalkeith.—The author stated that in gasworks only one condenser is required, if working efficiently, as no chemical agent has to be employed in its interior, its action entirely depending upon the amount of heat abstracted from the gas while passing along its series of pipes. This cooling influence thereby reduces the tarry and other vapours, carried mechanically along with the gas, leaving them, as a deposit either of tar or salts of ammonia, in the interior of the tubes of the condenser. During winter frosts, the action of the condenser is most efficient, but then the liability to stoppage is also greatest, so great that, in metropolitan gasworks, two, three, or four sets of condensers have to be maintained, and so connected by valves that, when one set becomes choked, another can be employed, setting aside those that stopped to be cleaned out. But in country gasworks, where no such thing as a second set of condensers exists, this source of annoyance is very great, and is much increased when a stoppage occurs at night, which frequently happens. In the old form of condensers, the necessity of stopping the flow of gas is not the only inconvenience—the awkwardness of having so many cap-plates to unscrew; so many lute-joints to remake; the dropping and misplacing of cap-plates, bolts, and nuts; and the dangerous position of the workman, generally on the top of a ladder. The author then described his improved condenser, in which cap-plates, bolts, nuts, and screws are altogether done away, and their place supplied by having the pipes straight, and open at top, protruding through a shallow cistern of water, whereby, and by means of moveable boxes, embracing the mouths of two pipes, and dipping into the water, and forming water-joints, any two neighbouring pipes can be connected together, and any number thrown out of work till it be ascertained where the obstruction lies, while the flow of gas to the lamps is never for a moment interrupted. The author explained his invention by excellent drawings, which he very clearly described, and he also showed its operation by a working model.—A discussion arose in which Messrs. Landale, Elliot, Sang, Black, and the President took part, commendatory of the beauty and efficiency of the invention, and complimentary letters from the manager of the Musselburgh gasworks, where it has been used efficiently for two years, and from Mr. Russell, of Elmfield foundry, Dalkeith, who made and fitted it up from the author's drawings and specifications

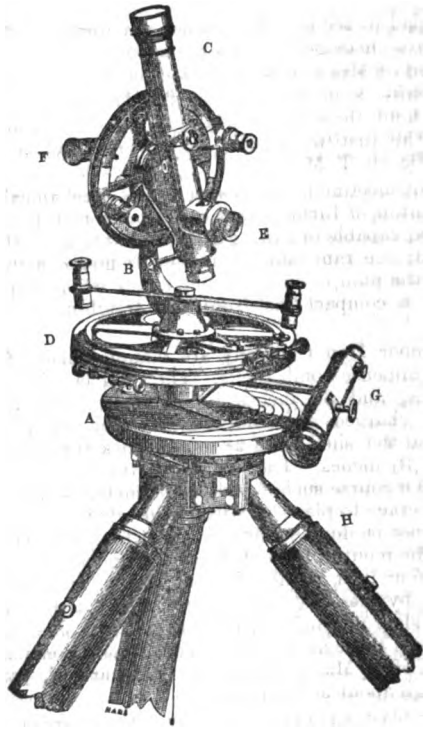
"An Instrument to be used in the Construction of Artificial Teeth."—By JOHN SMITH, M.D., Edinburgh.—This instrument consists of a metal stand, having attached a square pillar, graduated into tenths of an inch, and upon which a frame, containing a piece of ground glass, slides. The outline of a set of artificial teeth is to be traced upon the plate of ground glass from a pattern placed upon the stand of the instrument, and under the glass; while the required length of the teeth is indicated by the heighth at which the sliding frame rests on the graduated pillar. Much time and trouble were said to be saved by this instrument, both to the patient and the dentist, as the dimensions, &c. of the future set of teeth are capable of being obtained at the very first visit, and the work finished from these measurements without the necessity of any further attendance.

"New Gas-Stove for Churches, Chambers, &c., where no Flues can be obtained." By JAMES GALL, jun., sculptor, Edinburgh.—The peculiarity of this stove consists in having a comparatively low temperature spread over a large surface, by means of a very small consumption of gas. The heat is communicated to the room by radiation, instead of being poured upwards to the ceiling in a column of hot air.

"Method of Slicing Fossils for Microscopic Investigation." By ALEXANDER BRYSON.—Mr. Bryson described the various methods hitherto in use for slitting stones. That, in Edinburgh, the first specimens were prepared by which the microscope revealed hitherto unknown facts regarding fossil phytology. He described his self-acting method of slitting specimens, and a new *pneumatic chuck*, by which the specimen to be operated on is held in its position by atmospheric pressure instead of cement.

The following donation was laid on the table, viz.:—Catalogue of Select Examples of Ivory Carvings from 2nd to 6th centuries, preserved in various public and private collections in England and other countries, casts of which may be obtained from the Arundel Society,—classified in schools and periods. By Edmund Oldfield, M.A., Assistant to the Department of Antiquities, British Museum. Presented by the Council of the Arundel Society, Old Bond-street.

METFORD'S TRAVERSING THEODOLITE.



THIS new theodolite is by a really practical hand, one who has used the old one, and found by experience its deficiency. It combines several improved arrangements, is much less complicated than the instrument in general use, and from its simplicity can be made at less cost. One of its important features is a traversing stage A, which allows the instrument to be moved for a short distance in any direction without moving the legs when once set. The trouble and annoyance, even to an old practitioner, is well known, when the theodolite is set and the "bob" does not fall immediately over the stake, but is often an inch or more away from it,—when readjusted, the legs must be removed perhaps several times before obtaining the right position. By the new instrument he can do this in a few minutes, and thus save much time and trouble. Another improvement is the simplicity of the support, which is a strong curved arm B, so attached to the main centre as to allow of a transit motion to the telescope C, thus making the theodolite equal to an altitude and azimuth instrument, and so reducing the weight of the upper work as to prevent the usual top heaviness; the greatest weight of metal being at the base.

The horizontal limb D, holds a circular level, compass, and memorandum slates, and the transit telescope can be used through the perforated parts for very depressed angles. The construction of the pivots gives great stability on account of their having broad bearing flanges usual in levels; and the addition of the rectangular eye-piece E, enables the observer to remain in one position for all observations, or where the instrument is so placed that the proper eye-piece cannot be used, and would be found very useful in tunnelling. There are several other valuable improvements—in the long level F,—the check telescope G,—the round legs H (made of spruce for lightness),—in setting the object glasses in their cells, they being raised instead of sunk, and therefore easily wiped,—in lighting the wires,—and last, though not least, in the form of the case, which is pyramidical, with a loose handle over it; rendering it more portable, and so made that the theodolite can be easily put away in its vertical position when done with.

The instrument was constructed under Mr. Metford's own direction, whose long practice in railway engineering, in setting out curves, tunnels, and other difficult works, establishes him as an authority; and we can safely say he has rendered his new theodolite a perfect, strong and invaluable instrument both for the "field" and for astronomical purposes. Mr. Knight of Bristol is the maker, who patiently followed and assisted the inventor, suggesting many useful improvements during its progress.

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NOTES OF THE MONTH.

We are glad to see that Mr. James Fergusson, F.R.I.B.A., has been appointed manager of the Crystal Palace.

The Board of Examiners appointed by the Royal Institute of British Architects, in pursuance of the Metropolitan Buildings Act, have held their first meeting. The Board have recommended to the Institute that a certificate should be granted to Messrs. R. Booth, T. Myers, and G. Elkington.

At a recent meeting of the Institution of Mechanical Engineers Mr. S. Thornton, of Birmingham, exhibited a powerful Hydraulic Lifting Jack, capable of raising a load of 50 tons by the power of a single man; the ram being 8 inches diameter with an 8-inch stroke, and the pump ¾-inch diameter; the whole apparatus was arranged in a compact cast-iron box, weighing about 2½ cwt. altogether.

The Lowmoor Iron Company are manufacturing for government some immense bomb shells. The shell is 9 feet 5 inches in circumference, and 36 inches in diameter. The aperture by which it is charged and the fuse inserted are 2⅜ inches in diameter, and the shell itself 2½ inches thick throughout, and at the aperture 3¼ inches. The weight of the shell is 1 ton 6 cwt. 1 qr. 7 lb. Of course such a weight of metal will require considerable leverage to place it within the chamber of a mortar, and this cannot be done without a resort to machinery, to facilitate which the mouth of the shell is surrounded at a convenient distance by four lugs, made of wrought-iron and cast into the shell, which, by these means, is placed within the mortar. The cost of each shell unfilled will be 20*l.* to 25*l.* The mortars for the discharge of these monster shells are in course of manufacture at the works of C. Mare, Blackwall. They are of wrought-iron and will weigh about 35 tons each.

A monster blast was exploded lately at the quarry belonging to the Holyhead harbour works. A blast which had been formed with the labour of four or six men for the last ten or eleven months, and which required no less a quantity than six tons and a-half of powder to explode it, was let off in the presence of Mr. J. M. Rendel, the chief engineer, Mr. C. Rigby, the contractor, and a numerous staff of gentlemen connected with the works. The blast went off very satisfactorily, and it is calculated that the quantity of stone loosened by the explosion will be not less than about 60,000 tons.

APPOINTMENTS.

The Metropolitan Board of Works have elected Mr. F. Marrable Superintending Architect. The following gentlemen were candidates:—Messrs. W. Hosking, E. W. Lower, J. Blore, J. H. Taylor, F. Marrable, G. L. Taylor, G. Legg, H. Harrison, J. T. Wood, C. W. Pined, Thomas Taylor, John Barnett, E. C. Hakewell, W. Young, S. C. Gant, F. W. Stent. The Superintending Architect will be required to perform the duties defined by, or which may be requisite for enabling the Board to carry out the provisions of the Metropolitan Buildings Act, and Metropolis Local Management Act. "He must act as the professional adviser of the Board, on all matters relating to the office of District Surveyor, and on questions of fees and compensation connected therewith, and generally on all matters which the Board may desire to refer to him, and to perform all such other duties, incident to the office of Superintending Architect, as he may be required to perform. He must devote the whole of his time and attention to the duties of his office, as directed by the Act of Parliament. The salary, inclusive of travelling expenses, will be 800*l.* per annum."

The Holborn District Board of Works have elected Mr. Lewis H. Isaacs their Surveyor; the salary is 250*l.*

The Lea District Board of Works have elected Mr. Francis E. Thorne their Surveyor.

Mr. A. Laurie has been promoted to be the Chief Engineer and Inspector of Machinery at Chatham Dockyard, at a salary of 650*l.* per annum.

COMPETITIONS.

The Committee for building new National Schools at Luton, Beds, are desirous of receiving designs in competition for the erection of such schools.

The Guardians of the Poor of Bolton Union are desirous of obtaining plans, sections, and working drawings, for the erection of a Workhouse, to accommodate 1000 inmates, the cost of the buildings not to exceed 18*l.* per head. A premium of 50*l.* will be awarded for the best, and 30*l.* for the second best plan, but the Guardians will not be responsible for any payment for unsuccessful designs. The plans of the two successful competitors to be the property of the Guardians, who do not pledge themselves to employ either of the successful competitors in carrying out the undertaking. The designs must be sent in on or before Monday the 7th April.

The Council of the borough of Liverpool are about to erect a building for the purposes of the Free Public Library and the Derby Museum, and offer a premium of 150 guineas for the best designs, and 100 guineas for the second. The designs are to be sent in on or before Saturday, May 31st.

The Town Council of Hastings have awarded the premium of 10*l.* offered for the best design for laying out the Cemetery, to Mr. H. Carpenter, of Brighton.

The Burnley Market Company have awarded the premiums for the best designs for the improvement of the Market Place in Burnley, Lancashire, as follows:—First premium, of 15*l.* 15*s.*, to Mr. George T. Robinson, 23, Upper Parade, Leamington; and the second premium, of 10*l.* 10*s.*, to Messrs. Davies and Tow, of Chesterfield.

The Improvement Commissioners of West Hartlepool have awarded the premium of 20*l.* for the best design for a Market, to Mr. Thomas Oliver, Sunderland.

VICTORIA TUBULAR BRIDGE, MONTREAL.

In consequence of some doubts having been expressed as to the comparative economy of a tubular bridge to cross the St. Lawrence on the Grand Trunk line of Canadian railways, Mr. R. Stephenson has addressed the directors in a long and elaborate report, in which he enters fully into the subject, maintaining that a tubular bridge is, on the whole, the best as well as cheapest bridge that can be thrown across such a river as the St. Lawrence. He compares the work with other and as nearly as possible parallel instances in which such bridges have been preferred. One of these is adduced as the most remarkable parallel case, namely, the triangular or "Warren" bridge, erected by Mr. Joseph Cubitt over a branch of the Trent, near Newark, on our own Great Northern line. "The spans," he remarks, "are very similar, and so are the depths. In calling your attention to the comparison, you must bear in mind that all possible skill and science were brought to bear upon every portion of the details of the Newark Dyke bridge, in order to reduce the total weight and cost to a minimum. The comparison stands thus:—

	Span. ft.	in.	Weight including bearings. tons.	Length. ft.
Victoria Bridge	242	0	..... 275	257
Newark Dyke Bridge	240	6	..... 292	254

which shows a balance of 17 tons in favour of the Victoria tube. The Newark Dyke bridge is only 13 feet wide, while the Victoria tube is 16 feet, having a wider guage railway passing through it." Meantime the Victoria bridge approach works are progressing; but when the whole may be finished, is a question on which there seems to be much doubt and anxiety at Montreal.

NEW PATENTS.

PROVISIONAL PROTECTIONS GRANTED UNDER THE PATENT LAW AMENDMENT ACT.

Dated September 29, 1855.

2170. H. B. Barlow, Manchester—Improvements in mules and other machines of the like nature for spinning and doubling cotton and other fibrous materials. (Communication)

Dated October 15.

2301. J. Micklethwaite, Leipsic—An improvement in propelling and steering vessels

Dated October 16.

2309. W. Cotton, Loughborough, Leicester—Improvements in the manufacture of looped fabrics

Dated October 19.

2343. W. A. Gilbee, Rue de l'Echiquier, Paris—Improvements in the application of silicate of potash to hardening and preserving stones and calcareous materials. (Communication)

Dated October 24.

2375. J. Smith, Liverpool—Improvements in apparatus for giving alarm signals, and for extinguishing fires

Dated November 14.

2572. A. V. Newton, Chancery-lane—Improvements in the construction of locks. (Communication)

Dated November 15.

2577. G. Lister, Leamington—A cooling apparatus to be used in brewing

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Dated November 23.

2641. A. D. Lacy, Hall House, Knayton, near Thirsk, Yorkshire—Machinery or apparatus for agricultural purposes, to be used in combination with stationary steam power

Dated November 24.

2647. J. Elce and G. Hammond, Manchester—The employment of a new material in the manufacture of wicks for moderator lamps

Dated November 27.

2672. E. Peyton and D. Morrison, Bordesley Works, Birmingham—Improvements in the construction of metallic bedsteads and other articles to sit or recline upon

Dated November 29.

2695. J. E. A. Gwynne, Essex-wharf, Essex-street, Strand—Improvements in instruments for indicating pressure or vacuum

Dated December 3.

2717. F. Walton, Wolverhampton—An improvement or improvements in papier maché trays

Dated December 4.

2725. W. Hartcliffe, Salford—Improvements in weighting the top rollers of machinery used in preparing and spinning cotton and other fibrous materials

Dated December 7.

2765. W. I. Ellis, Salford—Improvements in the slide valve or valves of steam or other motive power engines

Dated December 10.

2785. P. A. Lecomte de Fontainemoreau, South-street, Finsbury—Improvements in obtaining motive power by means of heated compressed air. (Communication)

Dated December 11.

2795. J. Horsley, Cheltenham—Means of treating quinine and iodine, and other mineral medicines, in order to cause them to combine with cod-liver oil, or any other fish-oil, or with seed-oil

Dated December 12.

2805. R. W. Davis and D. Davis, Yellow Springs, Ohio—An improved vice

Dated December 15.

2836. G. Coats, Glasgow—Improvements in horse-shoes, and in attaching the same to horses' feet

2838. S. Twist, Birmingham — Improvements in castors for furniture and other purposes

Dated December 22.

2901. J. Newman, Birmingham, and W. Whittle, Smethwick—Improvements in the manufactnre of hooks and eyes, and in machinery to be employed in the manufacture of the hooks aforesaid

2903. W. Stevenson and W. Crawford, Lockwinnoch, Renfrew—Improvements in machinery or apparatus for carding or preparing fibrous materials

2905. I. Atkins, New Basford and Marygate, Nottingham, and M. Miller, Wollaton-street, Nottingham—Improvements in apparatus for measuring and regulating the flow of gas

2907. W. H. Zahn, New York, U. S.—Improvements in wind-mills and wind-engines

2909. J. Chesterman, Sheffield—An improved spring, especially applicable to the joints of knives, razors, scissors, and other like articles

Dated December 24.

2911. S. M. Gillet-Oudin, Blois—Improvements in making bread

2913. W. Symons, Tavistock—Improvements in the suspension roasting-jack

2915. G. Lean and R. Thomson, Glasgow—Improvements in weaving

2917. R. A. Brooman, Fleet-street—Improvements in treating beetroot and other saccharine vegetable substances, in order to extract alcohol therefrom, and at the same time render or leave the remaining parts of the vegetable fit food for cattle. (Communication)

Dated December 26.

2919. A. Tolhausen, Duke-street, Adelphi—Improvements in double-acting pumps. (Communication from D. W. Clark, U. S.)

2921. F. C. Hills, Chemical Works, Deptford—Improvements in economising fuel

2923. T. D. Duppa, Longville, Salop—Improvements in generating and heating steam. (Communication)

2925. C. May and E. A. Cowper, Great George-street, Westminster—Improvements in combing wool and other fibrous substances, and in machinery for that purpose

Dated December 27.

2927. E. A. Cowper, Great George-street, Westminster—Improvements in combing wool and other fibrous substances, and in machinery for that purpose

2929. N. Douglass, St. George's-in-the-fields—Improvements in the construction of lighthouses, beacons, piers, and other similar erections

2931. J. E. Cook, Greenock—An improved composition for preserving exposed surfaces, or surfaces liable to deterioration and decay

Dated December 28.

2933. J. J. Robert, Portugal-street, Lincoln's-inn-fields—The fabrication of torrified beetroot to supersede chicory as used in coffee, and with a great superiority

2935. F. Preston, Manchester—Improvements in the construction of military small-arms

2937. P. M. Salomon, Rue Neuve, St. Eustache, Paris—Improvements in the manufacture of gas from peat, and in the coke resulting therefrom, and also in the apparatus connected with that manufacture

2939. W. Rowett, Liverpool—An improved mechanical arrangement for lifting weights and other useful purposes

2941. J. P. Turner, Birmingham—A new or improved method of shanking metallic buttons, applicable to the heading of nails and other like purposes. (Communication)

Dated December 29.

2943. H. Redfern, Shelton, Stafford—Improvements in skates

2945. J. Broadbent and S. P. Youle, Manchester—Improvements in machinery or apparatus for cutting out the gores of umbrellas and parasols, which said improvements are also applicable to cutting out forms or shapes for other purposes

2947. W. Brown, Glasgow—Improvements in cooking and culinary vessels and utensils, and in the application and conveyance of heat

2949. S. Lees, E. Lees, and G. H. Newton, Oldham—Improvements in machinery for spinning and doubling cotton and other fibrous substances

2951. W. E. Newton, Chancery-lane—An improved process of tanning. (Communication from C. C. Knoderer, Strasburg)

Dated December 31.

2952. Sir J. S. Lillie, Pall Mall—Improvements in guns, firearms, and implements of war connected therewith

2953. C. Cowper, Southampton-buildings—Improvements in the treatment of coal, and in the purification, desiccation, and agglomeration of coal, and in machinery and apparatus for such purposes

2955. J. Taylor, Britannia Works, Birkenhead—Improvements in apparatus for raising and lowering weights

2957. J. C. Stevenson and J. Williamson, South Shields—Improvements in the manufacture of soda and alkali

Dated January 1, 1856.

1 H. Truelove, Liverpool—Improvements in gloves

3. J. Calvert, Strand—Improvements in extracting metals from their ores

5. W. B. Johnson, manager for Messrs. R. Ormerod and Son, Manchester—Improvements in steam-boilers and engines

7. J. Thurrell, Castle-street East, Oxford-street, E. M. Muller, Greek-street, Soho, and J. R. Chidley, Gresham-street—Improvements in transmitting facsimile copies of writings and drawings by means of electric currents

Dated January 2.

8. A. Shanks, Bobert-street, Adelphi—Improvements in machinery for cutting screws

9. W. Bullough, Blackburn—Improvements in machinery or apparatus for sizing yarns

11. G. Hamilton, Great Tower-street—Improvements in apparatus for weighing

Dated January 3.

13. R. Gill, Grove-terrace, Pomeroy-street, New-cross—Improvements in the arrangement and construction of the fire-flues and passages of steam-boilers, for facilitating and improving the combustion of smoke

15. C. Toye, Gloucester-street, Queen-square, Bloomsbury—Improvements in terry fabrics

17. J. W. Schlesinger, Northfleet, Kent—Improvements in the mode of using emery, glass, and sand, or other substances on linen or other material, and in the machinery applicable to the manufacture thereof

19. J. B. Lyall, Castle Frome, Hereford—Improvements in carriages

23. A. Stewart, Regent-street, and Rue de la Paix, Paris—Improvements in measuring the human figure, and fitting garments thereto

25. C. Mather, Salford Ironworks, Manchester, and C. Millward, Salford—An improvement in steam and vacuum guages

27. J. Fowler, jun., Bristol—Improvements in machinery for giving motion to ploughs and other implements used for cultivating land

Dated January 4.

29. H. B. Barlow, Manchester—Improvements in machinery for carding cotton and other fibrous substances. (Communication from C. de Bast, Ghent, Belgium)

30. H. Bach, Sheffield—Improvements in the application of glass to decorative purposes

31. C. Hart, Vale of White Horse Ironworks, Wantage, Berkshire—Improvements in portable steam-engines, and in apparatus connected therewith, for tilling and cultivating land

32. W. Simmons, Oldham—An improved hat body

33. R. Gray, Ridley-place, Newcastle-on-Tyne—Improvements in machinery or apparatus for moulding bricks, tiles, and other similar articles

34. T. Hudson, South Shields—An improvement in furnaces

35. T. Key, Bethnal-green—An improved knive-cleaning machine

36. E. H. Bentall, Heybridge, Essex—Improved machinery for pulping turnips and other vegetable matters

37. J. Wright, Burton-upon-Trent—Improvements in furnaces and fire-bars

38. G. T. Bousfield, Sussex-place, Loughborough-road, Brixton—Improvements in the manufacture of Jacquard, piled, or terry fabrics, when parti-coloured yarns are used. (Communication)

39. J. Betteley, Liverpool—An improvement in the rolling of iron for the making of ships' knees

40. F. W. Gerish, East-road, City-road—An improvement in the manufacture of cast hinges

41. R. S. North, Derby, and R. Peacock, New Holland, Lincoln—Improvements in metallic packages for pistons

42. W. O. Johnston, Broomhill Colliery, Acklington, Northumberland—An improvement in apparatus used for giving notice when the water in a steam boiler is too low

43. W. S. T. Clarke, Charing-cross—Improvements in ventilation

44. H. Bessemer, Queen-street-place, New Cannon-street—Improvements in the manufacture of iron and steel

Dated January 5.

45. R. Kammerer, Ostend, and C. Brewer, Chelsea—Improvements in electric clocks or timekeepers

46. J. Coxeter, Grafton-street East—An improvement in an apparatus for generating steam for medical and other purposes

47. H. Hindle, Cavendish-street, Ashton-under-Lyne — Improvements in valves or apparatus for regulating the flow of steam and gas

48. J. Corbett, Brierly-hill, Stafford—A new or improved method of preserving the tuyeres of blast furnaces

49. L. A. Thérèse, Paris—Improvements in harness

50. C. A. Hanson and J. Wormald, Belmont, Vauxhall—Improvements in signal and other lamps

Dated January 7.

51. V. Delperdange, Rue Verte, Schaerbeck, Brussels—Improvements in metallic and elastic packing

52. C. Jarvis and T. D. Clare, Birmingham—A new or improved oven or kiln to be used in the manufacture of coke and pottery, and for heating and drying generally

53. S. C. Lister and W. Tongue, Bradford—Improvements in machinery for combing wool, cotton, and other fibrous materials

54. T. Barter, Hart-street—An improved apparatus for administering vapour and douche baths

55. R. A. Brooman, Fleet-street—Improvements in machinery for boring and excavating. (Communication)

56. A. V. Newton, Chancery-lane—An improved mode of manufacturing rods, shafts, and tubes of iron and steel. (Communication)

Dated January 8.

58. M. E. Bowra, Basinghall-street—Improvements in the nature and manufacture of waterproof garments and other goods

60. G. B. Locke, Notting-hill, Kensington—Improvements in signalling from trains whilst in motion

61. E. T. Truman, Old Burlington-street—Improvements in artificial palates and teeth

62. H. Stuart, Liverpool, and T. Pritchard, Runcorn, Chester—Improvements in watches and chronometers, which improvements are also applicable to clocks and other timepieces

63. P. A. Lecomte de Fontainemoreau, South-street, Finsbury—Improvements in Jacquard machines. (Communication from J. Marin and L. P. de Maligny, Lyon)

64. S. Middleton, St. George's-row, Southwark — An improvement in the leather covered rollers used in spinning machinery

Dated January 9.

65. J. T. Pitman, Gracechurch-street—An improved mode of applying diastase and heat to the saccharification of starch. (Communication from F. V. O. Hyckert, Stockholm)

66. G. J. C. E. Hald, Manchester—Improvements in the construction of stoves. (Communication)

67. F. A. Gatty, Accrington—Improvements in the manufacture of lake colours

68. V. J. A. Martin and M. E. Martin, Paris—An improved grease-box for axles, journals, and other rotary parts of machinery

69. W. Barrie, Maida-hill—An improved reflective leveller. (Communication from A. Morlot, Montreux)

70. E. Hallen, Cornwall-road, Lambeth, and W. H. Kingston, Bandon, Cork—Improvements in communicating between the guards and engine-drivers, and between the passengers, guards, and engine-drivers, of railway trains

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71. J. Ashworth, jun., Turton, Lancaster—Improvements in lap machines or apparatus used in the preparation of cotton and other fibrous substances for spinning
72. A. Heegaard, Copenhagen and Regent-street—Improvements in making channels or flues
73. L. Alexandre, New York, U. S.—Improvements in propellers for vessels
74. C. M. Barker, Kennington-lane—An improvement in the pistons of steam engines
75. W. Watson, Leeds—Improvements in the arrangement of furnaces
76. H. Adcock, City-road—An improvement in casting iron and other metal

Dated January 10.

77. M. Billing and F. A. Harwood, Birmingham—New or improved machinery for the manufacture of paper bags
78. J. Darlington, Albert-street, Newington—Improvements in the manufacture or production of zinc or spelter
79. J. Erskine, Glasgow—The application of a new material or mixture for dressing or sizeing textile fabrics or materials
80. J. A. Herbert, Waterden-place, Guilford—An improved method for extracting the dirt, or the gum, or the colouring matter, or the principle, from various vegetable or animal substances or materials. (Communication)

Dated January 11.

81. J. Fernihough, Dukinfield—Improvements in steam boilers and apparatus for consuming smoke
82. J. H. Johnson, Lincoln's-inn-fields — Improvements in cards for Jacquard mechanism. (Communication from G. Mesmer, St. Louis, France)
83. J. H. Johnson, Lincoln's-inn-fields—Improvements in railway breaks. (Communication from J. B. M. A. Cochot, Paris)
84. T. C. Clarkson, High-street, Wapping—A combination of certain materials for forming and making improvements in ship and other pumps' tubes, which is also applicable for ship, carriage, and other building purposes and parts thereof
85. A. V. Newton, Chancery-lane—A new and improved method of curing meats, preserving provisions, and ventilating and cooling buildings, cars, and vessels. (Communication)
86. W. Pole, Storey's-gate, Westminister, and F. W. Kitson, Leeds—Improvements in railway wheels
88. W. Routledge, Salford—Improvements in cocks or valves for regulating the flow and pressure of steam, water, or other fluids

Dated January 12.

89. A. Bain, Westbourne-park-road, Paddington—Improvements in the construction of inkstands
90. E. C. F. Sautelet, Paris—An improved process of tanning
91. C. F. L. Oudry, Rue de l'Echiquier, Paris—Improvements in the preservation of metals and other solid substances
92. H. Emanuel, Hanover-square—Improvements in the manufacture of spoons, forks, and other similar articles in metal. (Communication)
93. W. Owen, Rotherham—Improvements in the manufacture of railway wheels and tyres
94. R. K. Day, Plaistow—Improvements in the manufacture of fuel
95. A. B. Freeland, Manchester—Improvements in the preparation of flour for the purposes of its better preservation and carriage, and in the machinery or apparatus employed therein

Dated January 14.

96. A. Tolhausen, Duke-street, Adelphi—Improvements in balanced slide valves for steam-engines. (Communication from E. D. Leavitt, jun., U. S.)
97. W. C. Homersham, Caroline-villas, Kentish-town—Improvements in machinery for the preparation of hemp, flax, and other fibrous materials
98. A. Pollak, Vienna—A new fusee or cigar light
99. A. Pollak, Vienna—Treating waste oily matters to obtain a product applicable to the manufacture of soap and other useful purposes in the arts
100. E. H. Bentall, Heybridge, Essex—Improvements in the construction of machinery for cutting and pulping turnips and other vegetable matters
101. N. S. Dodge, St. Paul's Churchyard—Improvements in the preparation or manufacture of leather cloth
102. A. Chambers, Canterbury, and W. H. Champion, Lynsted, Kent—An improved mode of working railway breaks
103. J. G. Ulrich, Mark-lane—Improvements in chronometers and other time-keepers
104. A. E. Melteste, Paris—Improvements in shirts
105. A. G. Brade, Paris—Improvements in recovering the wool from fabrics in which the same exists, together with silk or vegetable textile fabrics
106. W. Owen, Rotherham—Improvements in stoves and fireplaces

Dated January 15.

107. P. T. A. Nicoulland, Rue de l'Echiquier, Paris—Improvements in steam-boiler furnaces. (Communication from Le Docteur Bordone, Vincennes)
108. J. Hostage, T. I. B. Hostage, and J. Tatlock, Chester—Improvements in railway chairs
109. S. Sheppard, Birmingham—A new or improved tap or stop-cock
110. T. H. Bakewell, Welford-road, Leicester—Improvements in ventilating, warming, and cooling rooms and other places

Dated January 16.

112. H. M'Evoy, Hall-street Works, Birmingham—Improvements in locks, latches, and staples
113. H. Law, Essex-street, Strand—Improvements in heaving up slips for the repair or construction of ships or other vessels, and for a continuous action purchase for the same, which is also applicable to other purposes
114. W. Prangley, Salisbury—A novel instrument for exercising the third finger, and thereby facilitating the playing upon musical instruments
115. V. Scully and B. J. Heywood, Dublin—Improvements in the construction of inkstands, applicable in part to other vessels for the reception of fluids
116. J. Abraham, Birmingham—New or improved machinery for the manufacture of percussion-caps, and for cutting out and raising articles in metal generally
117. J. Hamilton, jun., Liverpool—Improvements in the posts or uprights employed in constructing electric telegraphs
118. J. Thompson, Sunderland—Improvements in ships' keelsons
119. J. Hamilton, jun., Liverpool—Improvements in constructing permanent ways of railways
120. J. Fowler, jun., Bristol—Improvements in machinery for ploughing land
121. D. Dring, Great Dover-street, Surrey—Improvements in machinery for cutting wood-pegs. (Communication)

Dated January 17.

123. P. A. Lecomte de Fontainemoreau, South-street, Finsbury—An improved apparatus for the prevention of accidents or collisions on railways. (Communication)
124. A. Tolhausen, Duke-street, Adelphi—An improved gas-meter. (Communication)
125. P. Rechten, Bremen—The taking of whales and other cetaceous fish by means of a harpoon constructed on entire new principles
127. J. Jackson, Manchester—An improved apparatus for retaining and releasing cords of "Venetian blinds," or cords, bands, or chains employed for other purposes
128. O. Philcox, Wilies-road, Kentish-town—Increasing the effect and the facility in fingering the pianoforte, organ, or other musical instrument having a keyboard
129. W. Chapman, Sunderland—An improvement in propelling vessels
130. J. J. Comstock, New York, U. S.—Improvements in generating steam. (Communication)
132. W. W. Squires, Liverpool—Improvements in preventing the bursting of pipes and tubes for conveying liquids

Dated January 18.

133. G. A. Tremeschini, Vicence (Lombardo Venetian)—Improvements in the electro-telegraphic communications
134. J. Moseley, Well-walk, Hampstead—The transport of all goods, merchandise, and valuable commodities whatsoever
135. M. de Bergue, Barcelona, Spain—Improvements in the permanent way of railways
136. J. Schloss, Wellington-chambers, Cannon-street West—A piston-bolt, or certain improvements in fastening travelling-bags, portmonnaies, cigar-cases, writing-desks, drawers, doors, and similar objects where locks, bolts, or clasps are employed
137. W. Marshall, Smethwick—Improvement or improvements in rolling iron for the manufacture of gun-barrels and tubes, and for other like purposes
138. H. G. Rule, Manchester—Improvements in machinery or apparatus for measuring water or other fluids
139. D. Shaw, Gee-cross, Chester—Improvements in looms for weaving
140. E. Myers, Rotherham—Improvements in buffers and other springs for railway and other carriages
141. N. S. Dodge, St. Paul's churchyard—Improvements in treating vulcanised India-rubber or gutta-percha. (Communication)
142. F. J. Manceaux, Paris—Improvements in fire-arms
143. J. Holden, Halifax—Improvements in machinery for cutting or carving and figuring wood
144. C. W. Harrison, Woolwich—Improvements in transmitting communications, and in the apparatus employed therein
145. J. Marzolo, Padua, and Paris—"A reproductive organ," printing with known notes any musical fancies, and equally applicable to pianofortes, melodiums, harmoniums, accordeons, and generally to all keyed musical instruments
146. J. Buckley, Oldham—Improvements in looms for weaving

Dated January 19.

147. A. Heaven and W. Booth, Manchester—Improvements in machinery for embroidering fabrics
148. A. Dawson, Barnes-place, Mile-end-road—An apparatus for converting small coals, or coal-dust, or small coals and coke, or coal dust and coke, with the admixture of water or other materials, into solid blocks of fuel, parts of which apparatus can be used and are suited for other purposes
149. E. Pickering, Chatham-place, Blackfriars—Improvements in the permanent way of railways
150. J. Armour, Kirkton Bleach Works, Renfrew—Improvements in bleaching, washing, or cleaning textile fabrics and materials
151. I. Barnes, Birmingham—Improvement in carriage-lamps
152. T. Horsefall, Deptford, and W. Turnbull, Rotherhithe—Improved machinery for breaking and preparing hemp, flax, and other similar vegetable fibres
153. F. Ayckbourne, Princes-street, Stamford-street—Improvements in the cleaning of knives and forks
154. H. J. Van den Hout, and E. Brown, Kentish-town—Improvements in the preparation of pulp for the manufacture of paper, millboard, and other like purposes
155. C. Robertson, Mark-lane—Improvements in mariners' compasses

Dated January 21.

156. S. Fenton, St. Mary's, Wavertree—Improvements in locks and fastenings
158. J. Genge, Wellington-street South—Improvements in the manufacture of boots or shoes. (Communication from H. M. Gillon, jun., Sezanne, France)
159. J. Pockson, Penton-street, Walworth—Improvements in the construction of roofing and other tiles

Dated January 22.

162. P. L. Tieffé-Lacroix, Metz, France—Improvements in machinery for cutting files
163. J. B. P. A. Thierry, jun., and J. L. Richard, Paris, and Baron H. de Martiny, Versailles—Improvements in preventing smoke by means of a fumivore hygienic apparatus
164. J. Gedge, Wellington-street South—Improvements in wrought-iron wheels (Communication from M. Charpentier, Paris)
165. J. Gedge, Wellington-street South—Improvements in bending, edging, and soldering tin. (Communication from M. Blanchefort, Briey, France)
166. P. A. Lecomte de Fontainemoreau, South-street, Finsbury—Improvements in machinery or apparatus for manufacturing nails. (Communication)
167. A. Robertson, Upper Holloway—A new manufacture of cases or canisters for dry goods, edibles, and such like commodities
168. T. Hitt, Tavistock-street, Westminster—Arrangements of machinery for converting reciprocating into rotary motion
169. E. Lawson, Leeds, and G. Jennings, Hunslet, Leeds—Improvements in reeling machines, for winding flax, cotton, wool, and other yarns
171. J. Francis, New York—Improvements in the manufacture of metallic boats
172. J. Beech and E. Jeffreys, Shrewsbury—Improvements in the means of supporting the rails of railways
173. H. E. Hoole, Green-lane Works, Sheffield—Improvements in stove-grates

Dated January 23.

174. J. Onions, Wellington-place, Blackfriars-road—Improvements in the manufacture of iron
175. G. Holcroft, Manchester, and J. Peacock, Salford—Improvements in castings for fencing horizontal shafts
176. A. Tolhausen, Duke-street, Adelphi—An improved manufacture of yarn from wool and other felting material. (Communication from J. H. Bloodgood, Rahnay, New Jersey, U. S.)
177. A. Tolhausen, Duke-street, Adelphi—Improved lock-joint for rails of railways. (Communication from J. R. Hilliard, U.S.)
178. W. Johnson, Lincoln's-inn-fields—Improvements in the treatment and application of fatty, resinous, and gummy substances, and in the manufacture of pastes, greases, and soaps. (Communication)
179. E. Lloyd, Dee Valley, Corwen, Merionethshire—Improvements in valves, and in the valve-gear of locomotive and other steam-engines
180. J. J. M. Neyer, Bartlett's-buildings—Improved mode of manufacturing bank-notes, checks, and other like documents
182. A. Turner, Leicester—Improvements in the manufacture of elastic fabrics
183. I. Barnes, Birmingham—Improvements in the manufacture of knobs and furniture for doors, drawers, and other similar purposes, parts of which improvements are also applicable to the manufacture of cornice poles and other like articles
184. J. Newman, Birmingham, and W. Whittle, Smethwick—Improvements in the manufacture of shafting for mill and engine purposes, which improvements are also applicable to the manufacture of shafts, poles, beams, masts, spars, and other similar articles, in which great strength or lightness, or both these qualities combined, may be required
185. S. Norris, New Peter-street, Westminster—Improvements in the manufacture of boots and shoes and other coverings for the human feet

Dated January 24.

186. L. A. R. Richoux, Paris—Improvements in clock-works
187. P. Samain, Meusnes, France—Improved levelling instrument
188. J. Solomons, and E. Lander, Birmingham—A new or improved cigar-holder

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189. C. Rothwell, Castle Ironworks, Stalybridge, Chester—Improvements in self-acting mules
190. J. Strafford, Stratford, Essex—Improvements in portable signal lamps for railway, marine, and other purposes
191. J. Gimson, and G. Gimson, Staleybridge, Lancaster—Improved apparatus applicable to steam-pipes used for the purposes of heating and drying, which said apparatus may also be used for other similar purposes where steam is employed
192. J. H. Johnson, Lincoln's-inn-fields—Improvements in air beds, mattresses and cushions. (Communication from J. C. L. Jacob, Paris)
193. G. B. Pettit and H. F. Smith, Oxford-street—Improvements in gas-heating apparatus
194. D. Fisher, Ranelagh-road, Thames-bank—Improvements in machinery for pressing, cutting, drying, and opening tobacco

Dated January 25.

196. A. Tolhausen, Duke-street, Adelphi—Improved machine for boring and other cutting operations in stone and other mineral substances of similar character. (Communication from H. Rees, J. Loudon, and O. Ahlstrom, New York)
198. A. Shanks, Robert-street, Adelphi, and F. H. Wenham, Effra-vale Lodge, Brixton—Improvements in water-gauges
200. J. Kershaw, Stockport—Improvements in apparatus for preventing the explosion of steam-boilers
202. J. Peak, Manchester—Improvements in machinery or apparatus for pointing and turning bolt-heads, facing-nuts, centreing, drilling, and similar purposes
204. A. Dalgety, Florence-road, Deptford—Improvements in vices, or gripping or holding apparatus
206. W. Owen, Red Lion-square—Improvements in pianofortes
207. A. J. Dessales, Rue des Enfans, Rouges, Paris—Improvements in oil-lamps, and in reflectors for the same for railway carriages and other purposes

Dated January 26.

208. G. H. Ingall, Old Broad-street, and G. O. S. Browne, Glasshouse-street, Nottingham—Improved method of railway signalling
209. A. Dalgety, Florence-road, Deptford—Improved self-acting stand or tilt for casks or barrels
210. G. Napier, Bath-street, Glasgow, and Adelphi—Improvements in the construction and arrangement of the flues, air-passages, and other parts of furnaces, and also in controlling the passage of smoke, and in heating and regulating the supply of air to facilitate combustion
211. J. H. Johnson, Lincoln's-inn-fields—Improvements in compressed air locomotive engines. (Communication from J. P. L. F. Datichy, Paris)
212. E. V. Gardner, Norfolk-street, Middlesex Hospital—Improvements in heating drying, desiccating, and evaporating
213. P. Doran, Cornwallis-street, Liverpool—Improvements in pneumatic apparatus for raising sunken vessels or other bodies under water, and for keeping afloat vessels or other bodies liable to sink
214. J. L. A. Hulliard, Paris—Improvements in the processes of singeing and dressing textile fabrics, and in apparatus for the same
215. W. Spurrier, Birmingham—A new or improved method of attaching handles to metallic tea-pots and other vessels, which method of attachment may also be applied to the fixing of castors on furniture and other like purposes
216. S. Stratham, Islington—Improvements in electric telegraph conductors
217. W. Dreschfeld, Manchester—Improvement in, or addition to, rollers employed in spinning
218. W. Beasley, Smethwick—Improvements in machinery or apparatus to be employed in rifling the barrels of fire-arms and ordnance
219. A. J. Walker, and W. Bennett, New York—Improved method of forming hat-bodies, or other felted articles

Dated January 28.

220. A. Longbottom, Moorgate-street, and W. Longmaid, Victoria Cottage, Stoke Newington—Improvements in apparatus for generating and heating steam
221. P. Brown and G. Brown, Liverpool—Improvements in the method of cleaning, dressing, and preparing a certain description of seed or grain, called "dari," and frequently called "millet," and thereby rendering the same suitable for food
222. J. Wormald, Manchester—Improvements in machinery or apparatus for folding "fenting," and making up goods or fabrics
224. A. M. Jullienne, Herblay, France—Improvements in breaks for railway trains
225. J. B. H. d'Auvergne, Blois, France—Improvements in portable writing or drawing desks
226. P. Samain, Meusnes, France—Improvements in tables, stools, and other pieces of household furniture
227. P. E. Guérinot, Rue au Maire, Paris—Stopping instantaneously two railway trains running against each other
228. R. Barrow, Garford-street, Poplar—An equilibrium slide valve for steam-engines
229. S. J. Goode, Aston, near Birmingham—A new or improved gas-stove
230. W. Asbury, Birmingham—A new or improved tap or stop-cock
231. J. H. Destibeaux, Paris—Improved waterproof fabric
232. J. Whitehead, Leeds—Improved machinery for fulling cloth. (Communication)
233. H. S. King, Cornhill—Improved apparatus for printing and embossing. (Communication)

Dated January 29.

234. G. Darlington, Minera, near Wrexham—Producing oxide of zinc from its ores
235. W. J. Simons, Royston—Improved governor for steam and other engines requiring governors
236. D. Foxwell, Manchester—Improvements in sewing-machines
237. W. H. Lancaster, and J. Smith, Liverpool—Improved arrangements for the application of gas and atmospheric air to the generation of heat in furnace or other flues, and the consumption of smoke
238. R. Thatcher, Oldham—Improvements in preparing for doubling or spinning cotton or other fibrous substances
239. J. Fleming, and G. Fyfe, Glasgow—The consumption of smoke in engine and other fires
240. O. Murrell, Bethnal-green-road—Improvements in swing looking-glasses
241. W. Fowler and W. McCollin, Kingston-upon-Hull—An improved thrashing machine
242. H. Chance, Birmingham—Improvement in the manufacture of moulded articles when using vitreous materials
243. S. P. Gladstone, Lea-Cottage, Orchard-house, Poplar—Improvements in the construction of masts and yards
244. J. F. Walton, Sarratt Hall, Rickmansworth, Herts, and H. Le François, Lambeth—Improvements in cleaning forks, spoons, stewpans, and other culinary utensils
245. A. Pope, Edgware-road—Improvements in the manufacture of iron, copper, tin, and lead
246. A. M. M. de Bergevin, Rue Labat, Montmartre, Paris—Improvements in preparing coal for burning and in the furnaces employed in consuming such coal

Dated January 30.

247. R. Winfield, Birmingham—An improvement or improvements in the manufacture of metallic bedsteads and other articles of metallic furniture
248. J. H. Walsh, Portland-place, Clapham-road—Improvements in omnibuses
249. J. Toward, Glasshouse-bridge Ironworks, Newcastle-upon-Tyne—Improvements in iron ship-building, and in iron plates therefor, which plates are also applicable to other purposes where great strength is required
250. C. F. Claus, Latchford, Chester—Improvements in the preparation of hides or skins, also applicable to the preparation of the entrails of animals
251. A. V. Newton, Chancery-lane—Improvement in the manufacture of cannon. (Communication)
252. W. Gossage, Widnes, Lancaster—Improvements in the manufacture of certain kinds of soap
253. T. F. Wilkinson, Bloomsbury-street, Bedford-square—Improvements in reaping and mowing machines
254. J. L. Stevens, London—Improvements in doors or apparatus for regulating the supply of air to steam boiler and other flues and furnaces
255. J. Gretton, Burton-upon-Trent—Improvements in brewing

Dated January 31.

256. J. Stokes, Birmingham—An improvement or improvements in fog-signals
257. H. Holford, and M. Mason, Newton Ironworks, Hyde, Chester—Improvements in machinery or apparatus for compressing metals and for manufacturing all kinds of metallic rivets, bolts, or similar articles
258. A. E. C. Descos, Paris—Improvements in consuming smoke
259. J. Mash, Manchester—Improvements in working the valves of steam-engines
260. G. Napier, Bath-street, Glasgow, and Adelphi—Improvements in apparatus for raising, lowering, and suspending boats from ships
261. H. Tylor, New Bond-street—Improved joint, applicable to cots, bedsteads, and other frames in metal
262. J. Kinniburgh, Renfrew—Improvements in moulding or shaping metals
263. J. Harrison and J. Odie, Blackburn—Improvements in machines for winding yarn or thread on to spools or bobbins
264. T. B. Turton, and J. Root, Sheaf and Spring Works, Sheffield—Improvements in buffer bearing and draw springs
265. H. Render, Manchester—A new or improved lubricating material
266. F. Kersey, Laurie-terrace, St. George's-road, Southwark—Improvement in the manufacture of drain-pipes
267. G. H. Cottam and H. R. Cottam, Old St. Pancras-road—Improvements in folding bedsteads and chairs
268. J. B. Anderson, East-hill, Wandsworth—Improvements in the manufacture of soap, parts of which improvements are applicable to preparing materials for the purposes of illumination, and also for the purposes of lubrication
269. T. Hurst, Tanner-street, Barking, Essex—Improvements in the connecting of the rails or metals generally used on railways
270. J. H. Johnson, Lincoln's-inn-fields—Improvements in gas-burners, and in regulating the combustion of gas. (Communication from P. A. Maunoury, Paris)

Dated February 1.

272. M. Ker, Cumberland Market, St. Pancras—A machine for sweeping carpeted and other floors
274. F. Preston, Manchester—Improvements in machinery for shaping and rolling metal
276. C. R. Moate, Old Broad-street—Improvement in securing and sustaining the rails of railways
278. W. Dray, King William-street—An improved cartridge-box and pouch
280. F. B. Fawcett, Kidderminster—Improvements in the manufacture of carpets
282. G. N. Hooper and W. Hooper, Haymarket—Improvements in springs for carriages, and for the cushions of carriages, chairs, mattresses, beds, and other similar articles
284. G. Duckett, Norfolk-terrace, Westbourne-grove West, Bayswater—Improvements in carts and vans
286. C. C. Joubert, Rue de Moscow, and L. A. Bordier, Rue de la Ferme des Mathurins, Paris—Improvements in motive-power engines
288. J. O'Meara Beamish, Trafalgar-road, Old Kent-road—Improvement in the manufacture of morocco leather

Dated February 2.

290. J. R. Day, Birmingham—A new or improved door-lock and latch
292. B. Burleigh, Northern Railway, King's-cross—Improvements in certain parts of the permanent way of railways
294. W. Goodman, Canning-place, Leicester—Improvements in machinery for producing knit or looped fabrics

Dated February 4.

298. R. Waller, Manchester—Improvements in preparing cotton and other fibrous materials
302. M. Whiting, jun., Manning-street, Bermondsey—Improvements in preparing for and in tanning hides and skins
304. N. Ager, Upper Ebury-street, Pimlico—Improvements in connecting spindles of locks and latches with their knobs and handles
306. T. Mills, Leicester—Improvements in machinery for the manufacture of looped fabrics

Dated February 5.

308. F. V. O. Hyckert, Paris—Improvements in heating
310. M. L. Parnell, Strand—Improvement in the construction of locks
312. F. M. Jennings, Cork—Improvements in bleaching vegetable fibres
316. T. Williams, Clerkenwell—Improvements in omnibuses

Dated February 6.

318. G. Napier, Bath-street, Glasgow, and Adelphi, and J. Miller, Cavendish-street, Glasgow—Improvements in the mode of driving and in applying screw-propellers to the propulsion of vessels
320. J. Dodgeon, Burnley, Lancaster, and J. W. Bateson, Rawtenstall, Lancaster—Improvements in looms for weaving
322. J. Inshaw, Birmingham—A new or improved pressure-gauge
324. C. V. de Sauty, St. Mary's-terrace, Walworth—The prevention of the leading or fouling of fire-arms
326. F. Prestage, Wylye, Heystesbury, Wilts—Improvements in locomotive engines
328. C. F. P. Funcke, Herdecke, Westphalia—Improvements in tanning skins and hides

Dated February 7.

330. R. Bleasdale, Rochdale—Improvements in the machines for spinning called throstles
334. H. Berlette, Boulogne-sur-mer—Improved apparatus for roasting coffee

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PATENTS APPLIED FOR WITH COMPLETE SPECIFICATION.

122. H. R. Worthington, New York, U.S.—A machine for measuring the flow of liquids, called a fluid meter—Jan. 16, 1856
160. J. W. Robson, Grundy-street, Poplar New-town—Improvements in machinery appertaining to waterclosets and pumps—Jan. 21, 1856
170. D. S. Porteus, Pai-ley—A rotary engine—Jan. 22, 1856
345. J. W. Duncan, Grove-end-road, St. John's-wood—Improvements in or connected with apparatus for the generation and application of steam for impelling purposes—Feb. 9, 1856

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WEST SHANDON, THE PROPERTY OF ROBERT NAPIER, ESQ.

(With an Engraving, Plate IX.)

In our February number we gave a description of the external and internal arrangement of this imposing mansion, illustrated by the side elevation which fronts Gaveloch. It was our intention to have given the entrance elevation, drawn to a corresponding scale with Plate III., but the extent of our engineering plates prevented us.*

COMPARATIVE STRENGTH OF LATTICE AND TUBE BRIDGES.

BOYNE VIADUCT *v.* VICTORIA TUBE.

SIR—In your number for this month (p. 101), you have alluded to the important report upon the Victoria-bridge, lately presented by Mr. Stephenson to the directors of the Canadian Trunk Railway. I hope it may be your intention to give that report in full, giving, as it does in detail the reasons which influenced Mr. Stephenson in coming to the conclusions he has arrived at with respect to that gigantic work. The document is one which cannot fail to interest the profession generally, although some may venture as I do, to take exception to one or more of the positions laid down. Individually, I am warranted in doing so, as my paper on the subject of lattice bridges laid before the Institution last session is especially controverted; and I venture to call the attention of the profession not so much to arguments on the comparative advantages of the lattice and tube systems, as to *facts*, inasmuch as some of the facts respecting the Boyne viaduct are, however unintentionally, *seriously misstated*. Mr. Stephenson institutes a lengthened comparison between the centre span of the Boyne viaduct, which is 264 feet between its supports, and the 242 feet spans of the Victoria. He says—I quote from the 'Canadian Railway and Steamboat Guide,' for January—"Let me compare the Boyne trellis bridge, held by some to be the most economical, with the present Victoria bridge. The Boyne bridge has three spans, the centre one being 264 feet, and the height is 22½ feet; it is constructed for a double line of way, and is 24 feet wide. The total load including the beam itself, the rolling load at two tons per foot, and platform, rails, &c., amount to 980 tons uniformly distributed. The bridge is constructed upon the principle of continuous beam, a term which signifies that it is not allowed to take a natural deflection due to it, but being tied over the piers to the other girders the effective central span is shortened to 174 feet—in fact, the principle changes three spans into five spans. Now, the effective area given for compression in the centre span is 113½ inches, which gives a strain for the 174 feet span of nearly six tons to the inch in compression."

Now, Sir, in this last sentence is a statement that the effective area of the top of the Boyne viaduct at centre is 113½ inches, whereas the FACT is, it is 227, or 113½ in *each* of the *beams*, and the strain when the span is 174 feet is, instead of 6 *tons per inch*, 2·8 *tons per inch*. The drawings I furnished to the Institution, with my paper, give Mr. Stephenson the areas of each beam. Again, the advantage of continuity he estimates at reducing the spans to 174 feet: this is quite erroneous also, inasmuch, as when the centre span alone is loaded, the centre beam is about 210 feet, and this gives the maximum strain to the top and bottom at centre, which strains are then 4 tons of compression on the top, and 5 tons of tension on the effective area of the bottom; and these are exactly what Mr. Stephenson claims to be the strains in the Victoria. We have thus, in the first place, the fact that the strain on the Boyne girders is less than *one*-half what Mr. Stephenson makes it, and we have the error of the length of beam, from which he deduces another erroneous conclusion, as follows:—"Let the Boyne bridge be supposed to have sufficient area in its top to resist 4 tons per inch (the proper practical strain), and let the spans be not continuous; it will be found by calculation that the area required at the top will be 364 inches, instead of 113½ inches, and the weight of the span would be found by calculation to come but little short of 600 tons, whereas it is now 368 tons. And if we suppose the Victoria tube to carry a double line of way and 24 feet wide, with a depth of 22½ feet, even if we double the size in quantity, the whole amount of weight will be certainly very little more than 500 tons for 242 feet span."

Here Mr. Stephenson, again going on his former mistake, says: "Let the Boyne bridge be *supposed* to have sufficient area in its top to resist 4 tons per inch;" the fact being, that the area *is* such that the strain under the maximum load *is 4 tons per inch exactly*; next, he calculates the area required at centre at the top, on the supposition that the spans were not continuous; and though the error here is small, even in this simple matter, whoever made out these details for Mr. Stephenson, is astray. Calculating on his own data,

L = span ..... = 264 feet.
W = uniform load..... = 980 tons.
h = depth of beam..... = 22½ feet.
S = compressive strain = 4 tons per inch.
A = required area at top in inches.

$$A = \frac{W\,L}{8\,h\,S} = 359\tfrac{1}{3} \text{ inches, instead of } 364.$$

To ascertain the weight of a single span of 264 feet, similar to the Boyne centre span, we have the sides *the same* as they are for the continuous beam; the roadway beams *the same*; the pillars at ends *the same*. The only difference is in the top and bottom chords, and these will be for a single span largely increased at centre, and much diminished at the ends. The present weights of centre span of Boyne viaduct are as follows:—

Top chords	105·5 tons
Bottom chords	109·1 „
Lattice sides, tension-beams, and compression-beams	82·8 „
Top cross-beams overhead	6·8 „
Roadway beams.....	46·1 „
Horizontal bracing, top and bottom	10·9 „
Pillars over piers, stays, stiffening pieces, &c.	24·8 „
	386·0 „

of which 24 tons is packing. Now, the top chord is at present 227 inches area at centre, it comes down to 137 inches near the ordinary points of inflection, and increases then to the piers between centre and side spans, where it is a maximum and is 265·2 inches.

If the beam was not continuous, the centre area would be 360 inches; the end area at piers might practically be about 100 inches, and intermediately it would be as the rectangle of the segments. The total material required would thus not exceed that actually used; the only advantage of the continuity (in consequence of the large passing load) being the decreased deflection and greater uniformity of section, it does not decrease the weight for this span at all, and therefore we must estimate the weight for a single span of 264 feet, the same as that erected.

We have then the Victoria design for a double line, 24 feet wide and 22½ feet high, according to Mr. Stephenson's statement, *over* 500 tons for 242 *feet span*; and the Boyne, for a double line, 24 feet wide, 22½ feet high, and 264 *feet span*, 386 tons, this 386 tons being a *fact*. Nor does even this comparison fully show the advantage on the side of the lattice, for the weights for such bridges will increase in a ratio above the square of the span; and if Mr. Stephenson's span be increased from 242 to 264 feet, the weight increased as the square, will, instead of 500, be 595 tons. The comparison is then—

Victoria bridge, design	595 tons
Boyne bridge, built.....	386 „

I will quite concede to Mr. Stephenson that so great a difference is not *solely* in the sides, but I believe it to be incidental to tubes to have a considerable waste of material in a great portion of the top and bottom as well as in the sides, inasmuch as the tube, even when least strained, must have at least quarter-inch plates with covers *all across* the top and *all across* the bottom, which give for certain portions a great waste of material.

Mr. Stephenson gives the deflections under testing load

Of Newark Dyke bridge	7 inches.
Boyne bridge.....	1·9 inches.
Victoria, *calculated*	1·6 inches.

And he again refers to his former erroneous supposition, that the span of the Boyne was under this test 174 feet *in effect*; the fact is it was really, in effect, under that testing load, a span of 210 feet, suspended from two overhanging beams of 27 feet each;

* The following errata unfortunately crept into the former plate and description, viz.:—Chandon for Shandon, and Gareloch for Gaveloch.

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and the deflection of the overhanging beam added to that of the centre beam of 210 feet, was 1·9 inches. The deflection calculated for the Victoria is about the same proportion.

So far as to facts; and here I would close, unwilling to enter in a letter on so large a subject as a general discussion of the theory of the matter, but I must call attention to one point which is assumed by Mr. Stephenson as undisputed. "One thing," he says, "is *certain*, that the sides of all these trellis bridges are useless, except for the purpose of connecting the top and bottom, and keeping them in their proper position. They depend upon their connection with the top and bottom for their own support; and since they could not sustain their shape, but collapsed immediately they were disconnected from these top and bottom members, it is evident that they add to the strain upon them, and consequently, to that extent, reduce the ultimate strength of the beams." Now, Sir, the argument is this:—*The sides of a trellis beam are not themselves beams, and therefore useless.* Did it not strike Mr. Stephenson that the same argument would prove that there was no strength in either *top* or *bottom*? What would become of the top and bottom, if the sides were disconnected—would they not "collapse"? And the argument from this, similar to Mr. Stephenson's, would be, therefore, the top and bottom do not add any strength, or anything but *strain*, to the *sides*.

The truth is, simply, that top, bottom, and sides form *one* beam; they are members of the one body, and each is as necessary for its office as any other member. Our duty is to apportion to each its proper form and functions; and I believe ere long it will be admitted that we do this best when we confine all the horizontal strains to a top and bottom chord at a maximum distance from each other, and make the vertical portion simply carry, in the most economical manner, the diagonal strains of compression and tension between these chords, at an angle of 45° to the horizon, and at right angles with each other.

I have thought it necessary thus publicly to call attention to the statements made respecting the Boyne viaduct. I do not for a moment suppose Mr. Stephenson has willingly misstated, and I would fain hope he will not allow the matter to remain uncorrected before the public, with his name attached to it.

JAMES BARTON.

Dundalk, March 19th, 1856.

USEFUL INFORMATION FOR ENGINEERS.*

No one is better able to give practical information to working engineers than Mr. Fairbairn, and with a laudable desire to impart his knowledge he has delivered lectures at the educational institutions in Lancashire and Yorkshire, the substance of which is now published, accompanied by numerous explanatory appendices, containing the valuable results of many carefully conducted experiments. The construction of boilers, boiler explosions, the combustion of fuel and the prevention of smoke, iron ship-building, the properties of steam and the construction of the steam-engine, form the principal topics of the lectures. We wish, indeed, that Mr. Fairbairn had put this information in another form, and instead of republishing what he said to the working engineers some years ago, that he had presented the matter, embodied with the results of more recent knowledge and experience, in a shape more adapted to consecutive reading and serious study. From the circumstances under which the lectures were delivered, the matter is necessarily in a great degree elementary; yet, there are mixed up with the elements, some considerations of the abstruse speculations of physical science, which are advanced with too much confidence as established facts. It is with Mr. Fairbairn as with many other men who have raised themselves to a position of high eminence without much previous academical training, that, feeling the merit of high mathematical attainments in their investigations, they are disposed to pay too much deference to the speculations of others who possess the kind of knowledge they desire, and who can invest with perplexing formulæ the simplest of questions, and talk authoritatively on the results of their calculations. Mr. Fairbairn has established his claim to rank among the most eminent of our engineers, by his great practical knowledge, gained by experience, aided by application of such scientific principles as are directly connected with the material matters with which he has had to deal; and when he departs from that position, and steps into the domain of physical investigations, regarding the nature of heat and the properties of steam, he ceases to be an original teacher, and gives merely a *refacciamento* of the opinions and crotchets of others. There is, however, enough of original matter in the work to render it a valuable addition to the library of the practical engineer, whilst the information at second-hand which it contains, relating to the properties of steam and the new theories of heat, may be considered a clear statement of the known facts, and of the speculative opinions on those interesting subjects.

We shall select for notice more particularly the facts connected with that branch of the subject with which Mr. Fairbairn may be considered to be best acquainted. Commencing with the construction of boilers and the strength of boiler-plates, he shows the fallacy of the opinion generally received that the rolling of such plates gives greater tenacity in the direction of their length than of their breadth. Experiments, the results of which are recorded in the following table, proved that the strength by rolling was equally distributed:—

Description of Iron.	Mean breaking weight in tons in the direction of the fibre.	Mean breaking weight in tons across the fibre.
Yorkshire plates	25·77	27·49
Yorkshire plates	22·76	26·37
Derbyshire plates	21·68	18·65
Shropshire plates	22·82	22·00
Staffordshire plates	19·56	21·01
Mean	22·51	23·10

The effect of heating the plates was also proved by experiment not to have the deteriorating influence commonly supposed, if the temperature was not raised above 600°, which is that of a dull red heat in the dark. Some experiments with cast-iron gave similar results, from which it was inferred that "the infusion of heat into metallic substances such as cast and wrought-iron, does not produce any serious diminution of their strength up to a temperature of 600°."

The rivetting of boiler-plates was a long time supposed to add to their strength, but the contrary effect is clearly shown to result from the piercing of iron plates, unless the plan of double rivetting be adopted, by which means the weakening effect of the piercing is almost, if not altogether, compensated.

Mr. Fairbairn is a strong advocate of high-pressure steam, on account of its economical advantages; and one of the points he frequently endeavours to enforce is, that, with proper precautions in the construction of the boiler, high-pressure steam may be safely employed. The form of boiler he most strongly recommends in this publication is the cylindrical, with spherical ends and two internal flues. It may be remembered that, at the meeting of the British Association at Liverpool in 1854, Mr. Fairbairn advocated flat-sided boilers as affording more convenient and better means of fixing internal stays than a cylindrical surface presents. It may be that the lecture was delivered before experiments with flat-sided boilers had proved their superior advantage, or it may be that he has returned to the former preference of the cylindrical shape. We incline to the latter opinion, from the circumstance that the use of thick plates and stays is represented to be very injurious. As Mr. Fairbairn is justly esteemed a great authority on all questions of boiler-explosions, we are somewhat surprised to find him expressing the opinion, that by increasing the amount of surface in a boiler by additional flues and tubes, the internal pressure is increased. That it may not be supposed we misrepresent his statement, we quote the following passage:—

"To show the amount of strain upon a high-pressure boiler, 30 feet long 6 feet diameter, having two centre flues, each 2 feet 3 inches diameter, working at a pressure of 50 lb. on the square inch, or 7200 lb. per square foot, we have only to multiply the number of square feet of surface, 1030, exposed to pressure by 7200, and we have the force of 3319 tons, which a boiler of these dimensions has to sustain."..."This is however inconsiderable when compared with the locomotive and some marine boilers, *which, from the number of tubes, present a much larger extent of surface to pressure.* Locomotive engines are usually worked at 80 to 100 lb. on the inch, and taking one of the usual construction, we shall find at 100 lb. on the inch, that *it rushes forward*

* 'Useful Information for Engineers; being a Series of Lectures delivered to the Working Engineers of Yorkshire and Lancashire; together with a Series of Appendices, containing the results of experimental inquiries into the strength of materials, the causes of boiler explosion, &c.' By W. FAIRBAIRN, F.R.S., F.G.S., &c. London: Longman and Co. 1856.

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on the rail with a pent-up force within its interior of nearly 60,000 *tons.*"

Among the causes that are assigned to account for the bursting of boilers, the supposed explosion of hydrogen gas, generated by contact of water with the red-hot boiler-plates is a favourite assumption, when the circumstances seem to admit of no satisfactory explanation by the gradually accumulated pressure of steam. Mr. Fairbairn denies the operation of such a cause, and it seems extraordinary that any one having pretensions to scientific knowledge should for a moment have entertained such a notion. Even admitting the circumstances to be the most favourable possible for the generation of hydrogen gas, there would be no explosion capable of producing such destructive effects. The decomposition of water, when injected on red-hot iron, is produced by the absorption of the oxygen by the metal to form an oxide of iron; and as no explosion of hydrogen can occur without a large admixture of oxygen, the very generation of the hydrogen would necessarily deprive it of explosive power. It is not probable, however, that any large quantity of water would be decomposed on contact with the red-hot boiler-plates, encrusted, as they generally are, in a manner to prevent such chemical combination from taking place. But, even admitting the possibility of the generation in the boiler of an explosive mixture of the two gases, it would require a temperature approaching a white heat to produce an explosion. An erroneous notion of the impulsive force of an explosion of mixed hydrogen and oxygen, also obtains, arising partly from the destructive consequences of such explosions of large volumes of the gases in coal mines. In the course of some experiments we instituted to ascertain the force of exploded hydrogen and oxygen, the result showed that it did not in reality exceed eight atmospheres, which is an amount of pressure that all well-constructed high-pressure boilers ought to bear.

The consideration of the prevention of boiler explosions forms an important portion of Mr. Fairbairn's "Useful Information." He is inclined to attribute most of the accidents that occur to the inefficient action of the safety valves, and he recommends several means of producing a sufficient discharge of steam, when from any cause it is raised to a dangerous amount of pressure. The plan he adopts in the construction of boilers, is the introduction of one or more lead rivets, which melt when the temperature is raised above the safety point, and afford an outlet for the steam, and thus sufficiently indicates the danger, if it do not altogether remove it. The plan is a modification of the fusible metal safety plugs, but it is only brought into action in cases of extreme danger. The fusible metal safety plugs, as usually constructed, are attended with great inconvenience, as they allow the whole of the steam in the boiler to escape after having been melted; but Mr. Fairbairn admits their superiority as a means of safety. An American invention, which was some years ago submitted to one of our most eminent engineers, effectually prevented that inconvenience, for as soon as the temperature which caused the dangerous pressure was lowered, the metal solidified and prevented the further escape of steam. The practicability and security of the safety valve was admitted, but the objection raised to its adoption was, that the safety valves then in use were quite sufficient for the purpose, if properly made. It is in this manner that useful inventions are too frequently "pooh-poohed" by practical men, who dislike to depart from the beaten track unless they lead the way.

Mr. Fairbairn, who has taken a prominent part in the construction of iron ships, naturally prefers them to ships made of wood, and he shows, by a variety of facts and illustrations, the superior advantages of metal plates in naval structures. Even for war ships he contends that iron is a much better material than wood, and he considers the experiments made by the Admiralty, to try the effect of shot on such ships, were unsatisfactory and fallacious. We shall not, however, follow Mr. Fairbairn into this branch of his subject, and shall conclude our notice of this really useful work with an extract relating to a subject more immediately connected with the engineering profession.

Advantages of High-Pressure Steam.

"Taking into consideration the superior economy of high steam, *worked expansively*, it is quite evident, that in all future constructions, either of boilers or engines, we must look forward to the use of a greatly increased, instead of a reduced pressure of steam. Indeed, I am so thoroughly convinced of the advantages inseparable from this application, as to urge upon you the necessity of preparing for greatly increased progress and greatly increased pressure in all the requirements, appliance, and economies of steam as a motive power. It must appear obvious to every reflecting mind, that steam generated under pressure, and compressed into one-fifth or one-sixth the space that it formerly occupied, and that again applied to an engine of little more than one-third the bulk, must be a desideratum in the appliance of an agent so powerful, and so extensively used. Look at our locomotives of the present day, and tell me whether we are, or are not successively progressing in effecting a closer alliance between the two sister sciences of mechanics and physics; and tell me whether or not the community is not secured equally well from risk, and greatly benefited by the change? Let us calculate, for example, the duty performed, and the force applied to one of our largest class of locomotive engines travelling with a train at the rate of 45 miles an hour, and we shall find the amount of power given out to exceed that of 700 horses, or as much as would be required to drive the machinery in some of our largest factories. And why not work our factories upon this principle? and why not propel our largest ships by engines of this description? There is no reason why it should not be done, and that with greatly increased economy, by introducing a well-directed system of condensation along with that of highly attenuated steam."

EXPEDIENCY OF REMOVING THE GAOL OF NEWGATE.

THE following are extracts from the report of the committee appointed to inquire into the state of Newgate, laid before the Court of Aldermen of the City of London:—

"Having proceeded to consider the reference, we beg to report that the state of Newgate in its present structural condition is such as to render any satisfactory classification of the prisoners altogether a hopeless task, and the carrying out of any well-considered plan of discipline an utter impossibility. No satisfactory separation can in its present condition be effected, because of the insufficient number of cells, and no satisfactory supervision is practicable with anything like the present number of officers. We believe that as much as could be done in reference to these great desiderata is done; but, until some very important alteration is made in the physical structure of the interior of the building, Newgate must continue to be a standing reproach to the city of London. The want of proper supervision, and its impossibility in the present state of the gaol, are, and must be, sources of constant anxiety to the governor, if only on account of the safe custody of the prisoners. Groups of half-dozens or more being locked up together for many long hours without the presence of an officer, they naturally discuss the chances of escape. It is well known that last year three prisoners got away by breaking out of the gaol: and within this very month an attempt was made during one night to escape by breaking through the wall of one of the wards; the number there confined together was five, three of whom are old offenders; the other two are supposed to have been unwilling, inactive observers. They cleared away the brickwork by raking out the joints of mortar with a long nail, but their progress was checked by the solid massive masonry of the exterior face of the wall, and the next day the imperfectly concealed operation was discovered by the officers. It need hardly be stated that no mischief of this sort could possibly have been attempted at Holloway. Your special committee have had a plan under consideration by which it is believed that Newgate could be cured of its great defect, and the city relieved from the reproach of standing almost alone in having a gaol without a system. The plan would give 120 separate cells, and we are of opinion that if such a plan were carried out it would enable the governor to establish a degree of separation and supervision which would be almost, if not altogether, unobjectionable. The cost is estimated by the City Architect at 10,000*l.* We have also given our attention to another plan of a comprehensive nature for the entire demolition of the courts and of the gaol and the reconstruction of the courts and such a portion of the gaol as might suffice for the custody of prisoners while the trials were going on; the object of this plan being to dispense with Newgate as a prison, except only as above stated. A plan has also been submitted to us for such addition to the prison at Holloway as would enable it to receive the prisoners now kept at Newgate. The cost of these combined operations—that is, the reconstruction of the criminal courts and a portion of Newgate—is estimated by the City Architect at 87,000*l.*, from which may be deducted the value of a piece of land at the Old Bailey set free by the alteration of the system, which the City Architect estimates at 9000*l.* In working out these plans the City Architect has so arranged as to permit the

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smaller one to form an integral part of the larger one, so that if it should be the pleasure of the court to carry out the recommendation of the committee in adopting the first-named plan, and it should hereafter be deemed expedient to carry out the larger one, no material alteration would be necessary, and but little loss would accrue. That portion of the reference which relates to the expenses of the gaol, and also as to what steps it may be expedient to adopt with regard to the officers, their salaries and duties, cannot well be dealt with until the question as to the alteration of the gaol is determined. The question as to the expediency and legality of abolishing the prison altogether having been considered, it does not seem to be expedient, and the legality, therefore, hardly seemed to be an object to be ascertained, and that has therefore not been made a matter of inquiry."

IMPROVEMENTS IN PRESSES.

THOMAS TAYLOR LINGARD, Manchester, *Patentee*, May 8, 1855.

This invention of improvements in presses consists of arrangements in which two or more inclined planes are placed underneath a table, in such a manner that by moving two or more wedges or rollers in the direction of the length of the inclined planes, the table will be forced upwards.

FIG. 1.

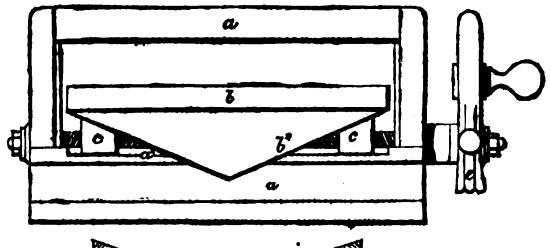


FIG. 2.

Fig. 1, is a side elevation of a press, such as is used for copying letters, &c.; fig. 2, is an enlarged view of the wedges, showing one of the means adopted for working them, namely a right and left-hand screw; fig. 3, shows another method of working with either a right or left-hand screw only; and fig. 4, shows another method of working by means of eccentrics: in this figure rollers are substituted for wedges.

In fig. 1, *a*, is the main frame of the press; *b*, the table, having two or more inclines *b**, *b**, placed underneath it; *c*, *c*, are two wedges, which run under the inclines upon bars *a**, *a**, of the frame *a*, and which, when drawn together, cause the table *b*, to ascend. These wedges are moved by means of the right and left-hand screw *d*, which is turned by a handle *e*; the wedges *c*, *c*, are thus caused to advance towards or recede from each other horizontally, and at the same time move along the inclined plane,—thus forcing up the table and effecting the pressure between the top of the frame and the moving table.

FIG. 3.

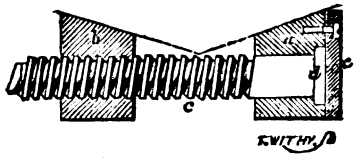


FIG. 4.

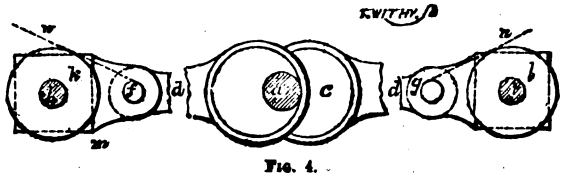


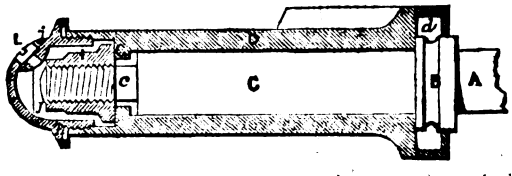
Fig. 2, shows the wedges and the right and left-hand screw. *c*, *c*, are the wedges, and *d*, part of a screw, having the end *a** cut into a right, and the end *b** into a left-hand screw.

Fig. 3, shows a method of attaining the same end by means of a single screw. *a*, and *b*, are the two wedges; and *c*, is a screw, having a collar *d*, upon it. The screw *c*, is free to revolve in the wedge *a*, but is prevented from moving longitudinally by the collar *d*, and the cap *e*; so that when the screw is drawn along, the wedge *a*, must move with it. The other wedge *b*, is formed into a nut, in which the screw *c*, works. In this arrangement the screw *c*, is turned round as before, and working in the nut *b*, draws the wedges together or pushes them apart by the collar *d*,—causing the table to ascend or fall, according to the direction in which the wedges are moved. This method has double the power of the one first described; but as the screw has a movement in the direction of its length, it is not in all cases so convenient. Rollers may, in every instance, be used instead of wedges; and, therefore, to show the application they have been substituted in fig. 4, which also, at the same time, shows another method of causing them to advance and recede by means of eccentrics. In this fig. *a* is a shaft, upon which are two eccentrics *b* and *c*. These eccentrics are clipped by connecting-rods *d*, *e*, which have their other ends attached to the pieces *f*, *g*; so that when the shaft *a*, is turned round, the eccentrics *b*, and *c*, and the connecting-rods *d*, and *e*, cause the pieces *f*, and *g*, to advance towards or recede from each other. The pieces *f*, and *g*, have pins *h*, and *i*, upon which are the rollers *k*, *l*. These rollers may be made double, that is, one to run upon the horizontal surface, shown by the dotted lines *m*, and the other upon the inclined surface, shown by the dotted lines *n*. The patentee remarks, that the rollers or wedges may be worked by means of cranks or levers in the same manner.

IMPROVEMENTS IN AXLE-BOXES.

JOHN HENRY JOHNSON, Lincoln's-inn-fields, *Patentee*, October 30, 1854.

This invention relates to a peculiar construction of axle-box for ordinary conveyances, whereby greater strength and durability is obtained, as well as a better system of lubrication.



The figure is a longitudinal section of the axle-box. The box D, is bored and polished to receive the journal C, of the axle A. This box is composed of cast-iron, and formed with a contracted portion or internal annular projection G, of sufficient size to afford a good bearing for the nut I, at the end of the axle. The journal C, which is turned slightly conical, is terminated by a cylindrical portion *c*, of smaller diameter, which is prolonged, and has a screw-thread formed upon it, to receive a wrought-iron nut I. This nut is provided with a shoulder, in order to present a greater frictional surface against the collar G: and at its other end it is made hexagonal, to receive a screw-key. The part H, of the axle-box is of a greater internal diameter than the rest, in order to afford space for the reception of the nut I: it is also tapped or screwed internally, to receive the oil reservoir J, which is screwed into it. This cap or reservoir is furnished with a flange *j*, in the face of which is cut an annular groove for the reception of a leather washer *k*. The exterior of the oil reservoir is made octagonal, to receive the screw-key. At the back of the hemispherical portion of the cap J, there is an interior enlargement, having a hole formed therein for the introduction of the oil; which hole can be closed by the screw-plug L. The larger end of the journal C, is fitted with a grooved washer or collar B; and the axle-box D, is cast with an annular chamber *d*, which encloses and entirely covers the collar B. The oil for lubricating this extremity of the journal is put into the annular space *d*; the groove in the washer or collar B, assisting in retaining it there. The rotation of the box D, and consequently of the chamber *d*, keeps up a constant lubrication of the journal—the oil in the chamber *d*, not requiring renewing for a considerable period. The axle-box is thus supplied with oil at one end by the reservoir *d*, and at the other by the reservoir J, and is held firmly in its place on the journal C, by the annular projection G, and nut I, and will remain in good working order without requiring any further care or attention for a considerable time.

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REVIEWS

Lectures on Gothic Architecture, chiefly in relation to St. George's Church, at Doncaster. By EDMUND BECKETT DENISON, M.A. Doncaster: G. and T. Brooke. 1856.

Mr. Denison's name has been frequently before the public of late, in connection with the Houses of Parliament and its clock, and at the Institute of British Architects in discussing the various and advisable methods of hanging bells in church-towers. His well written manual on the construction of clocks forms one of the numbers of Weale's "Series," and is perhaps the only modern publication on the subject. But, besides these studies, and his recognised position at the bar as one of her Majesty's counsel, he is no mean admirer and student of architecture; and the exposition he gives of his opinions in the work before us, shows that he is not one of those amateurs and would-be dictators, who, in their rage for novelties or favourite theories, often overlook the prime quality of common-sense. He discourses very freely both in matter and manner, adopting a familiar style throughout, as if written *currente calamo*; but this, while it does much for the readable character of the book, not unfrequently betrays him into sundry repetitions and grammatical carelessnesses which one does not expect to find in print.

There are two things which soon become apparent—first, that Mr. Denison is, in respect to architecture, a thorough "Goth;" and, secondly, that while he acknowledges the services of Mr. Ruskin to the art, he fearlessly combats many of his most cherished propositions.

"In my younger days," says he, "the world still believed that Sir Christopher Wren, who built the new St. Paul's, and Inigo Jones, who mended up the Norman front of the old St. Paul's with a Corinthian portico, were the greatest architects the world had ever seen, except a few Italian ones who built in the same style. And if a boy had any curiosity about architecture, he was shown pictures of Greek temples, arches of Titus, and Italian churches, and harangued about 'the Five Orders,' as if they were the Ten Commandments of architecture. I remember certain vague attempts to infuse that knowledge into me, and their ending in a kind of vague and irreverent suspicion that, as the builders of York and Beverley minsters evidently knew or cared very little about the five orders, the said orders were nothing better than a humbug."

The lectures before us were delivered at the town-hall at Doncaster, and suggested by the rebuilding of the magnificent church now in progress there. "I made what speed I could to improve the small amount of such knowledge which I possessed; for I had had to do with architects before, and I confess I had not faith enough, even in the best, to feel inclined to take whatever plans might come out of his office, without being satisfied that they were at any rate the best he could produce, nor to refrain from complaining of what appeared to be wrong the moment I saw it, instead of waiting till the end, in the hope that it would turn out right." However plausible this avowal, it must, we think, be considered to savour largely of presumption, and advocates a degree of meddling interference, which might be quite as fairly claimed on other questions—legal, for instance; but this, perhaps, Mr. Denison would not so readily admit. Yet, though there cannot be a greater advantage to our profession than that the public, and especially the thinking portion, should appreciate its labours, next to the pertinacious obstinacy of "know-nothing" arbiters, there can scarcely be a greater clog to improvement and independence of action than where a professional man is expected to accommodate himself to some half-dozen wiseacres, who, committee-like, will take to themselves the credit of any good results, but as resolutely ignore what may turn out to the contrary, throwing the responsibility (as, forsooth, it is termed) on the shoulders of the nominal architect. Select your own adviser, give him at the outset your ideas, if you choose,—let him have every facility, but do not fetter his deliberations; let the work he shall produce be his own, and he will stand or fall by its merits. This will at least leave him unbiassed, and arouse that stimulus by which, in the main, great things are to be achieved.

As we have already hinted, Mr. Ruskin's dogmas are early referred to, and their character thus generalised:—

"The reading world seems to be almost divided into enthusiastic admirers of his original genius, his correct taste and infallible instinct on all matters of art, as well as the singular eloquence with which he delivers his opinions, on the one hand; and, on the other, the deriders and denouncers of his artistic heresies, his bad taste, his violent prejudices, and, above all, the unexampled arrogance and conceit of his style. I confess the many valuable opinions (his writings) contain would have a better chance of being received, and the second-rate architects, who hate him, the better chance of being laughed at as they deserve, if he could be more easily acquitted of the charges of dogmatism and arrogance, such as one can hardly find elsewhere (except in the columns of a religious newspaper), of logic so inconclusive as to be sometimes childish, and of pushing his opinions to obvious extravagance. Another great fault of his is the habit of affecting to decide questions of taste by giving nicknames to things he does not like; such as calling King's College chapel like a four-legged table upside down, which it is not, and never could have appeared to him or any one else."

(Yet, Mr. Denison thinks it "perfectly right" to call such ornaments as the architect of the Leeds Town-hall exhibits upon its lower corners, "soup-tureens;" and those on the corners of his proposed tower, "tee-to-tums," "because they resemble nothing else upon the face of the earth;" and in condemnation of such ornaments he gives them "their proper nicknames.")

"In reading Mr. Ruskin's books, therefore, you must not be frightened merely because you see something that is generally admired, called by some ridiculous nickname; but consider whether it deserves it. If it does not, the ridicule only falls on the person who avails himself of such a very small and cheap style of criticism. Another fault in them you will very soon discover without being told of it, viz., that they are much too long and spun out with perpetual dissertations, which may be relevant to something which Mr. Ruskin is thinking about when he writes them, but certainly are not to the subject before the reader. Notwithstanding these rather serious blemishes, however, he has done more than any other writer—indeed, no other that I know of has done anything worth notice—to call the attention of mankind to what may be called the moral characteristics of Gothic architecture, as distinguished from Classical or Renaissance. I should think few persons, and quite as few architects as others, can read his books without learning a great deal from them which it is worth while to know, and without finding reasons which they never thought of for either giving up or holding more distinctly many opinions which have been floating in their minds in a somewhat hazy way before; for it is by no means to be inferred that his reasons are always bad or absurd because they are sometimes."....."I wish that I could read to you some of Mr. Ruskin's eloquent denunciations of the baseness, and the miserable and monotonous effect of ornament either done by machinery, or done by men as if machinery had done it; but, unfortunately, his style of writing is so diffuse, and so constantly involved with what is irrelevant and inconclusive, that I cannot at present find, in all his five volumes on architecture, anything that I can read without injuring the effect and the conviction which I think will be produced, if you have patience to read the whole of what he has said in numerous passages on this subject."

This is plain dealing, and very much to the point. With all Mr. Ruskin's flow of imagery and power of language, even his most devoted admirers must acknowledge that in rhapsodical phrases he too often deserts the main argument, which loses its pith and pungency through the plethoric style in which it is propounded. Like many others, we are anxiously waiting to see how, practically, Mr. Ruskin would bring his notions to bear. In his Edinburgh lectures he gave an inkling on the subject, but only as to windows, enrichments, and some subsidiary features; we are wishful to see him develope his ideas on some complete subject. It may be replied, the proper sphere of some persons is investigating theories alone, as equally as it is that of others merely to put them in execution. Grant to a certain extent this useful division of labour, but surely the man who originates a theory should be able to exhibit its due practical complexion, else it is in danger of being misconstrued, if not regarded as an idle dream. In the case of another facile writer, Mr. Petit, the public were lately favoured, in the Architectural Exhibition, with what may be presumed to be that gentleman's idea of a country house, inasmuch as there were views of one being erected for himself, and, we are given to understand, entirely after his own plan. We simply quote this as an instance of theories practically brought to bear, without further pronouncing an opinion. As Mr. Denison would perhaps fain be classed with Mr. Ruskin, Mr. Petit, and others, as enunciators of the true principles of art, in due time, it may be, we shall see some actual results; and it appears, from remarks thrown out here and there, he is already somewhat trying his hand by "advising" with the architect of the new Doncaster church. Of windows, generally, he would be deemed a judge, and he claims the merit of being joint designer of the Doncaster east window, which, as being executed, differs from that originally contemplated; the latter, says he, "without knowing why, I never liked, though I soon

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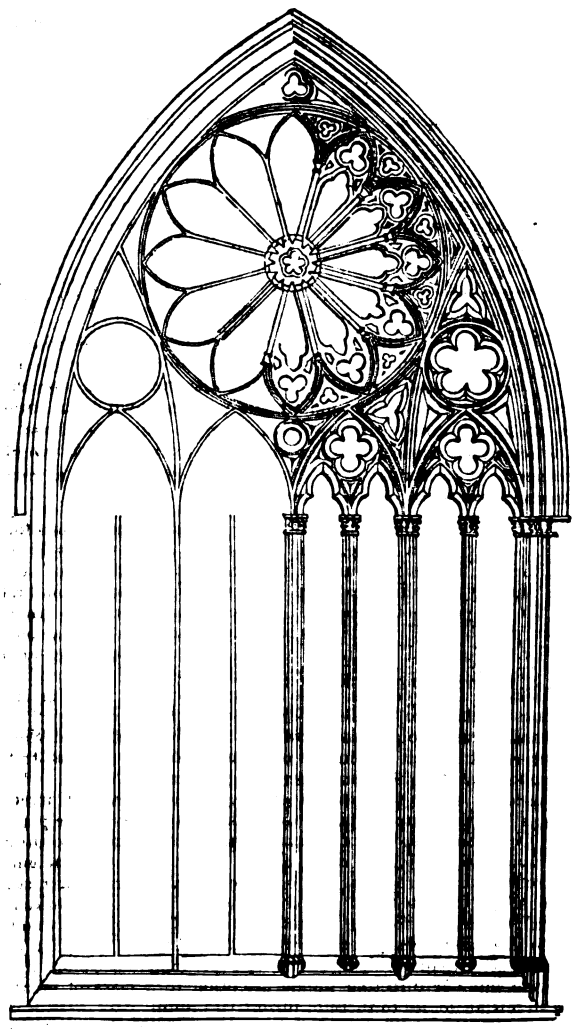
found the reason when I came to draw it for these lectures." "The result of various alterations proposed by both of us, in which I contended for high arches and a large wheel in the window, of which this is a drawing; and which, in my opinion, is not surpassed by any window not only of modern but of ancient times." We subjoin a diagram of this window, which may be generally described thus:—It consists of eight equal lights comprised under a high pointed arch, the two outer lights on each side are enclosed by the same arch reversed, and in the central space is inscribed a large wheel window of twelve lights. The subdivisions of the tracery are composed of cinquefoils, quatrefoils, and trefoils, richly moulded, and the jambs and mullions are shafted. This window is 22½ feet in the clear width, and the wheel is about 15 feet.



EAST WINDOW OF DONCASTER NEW CHURCH.

Some excellent observations are made respecting the different effects of windows under different treatment, and particularly as to their depth or recessing from the face of the wall. It is well known that in the great churches of old times, the walls were generally much thicker than our modern ones, though that thickness was often made up of rubble. But notwithstanding this, the best windows were generally set midway in these thick walls; so that the glass in a large window would be seldom less, and often more than 2 feet from the external face of the wall. It is too little considered in new buildings, what an advantage this affords to the appearance of a structure; and even if we need not follow our forefathers in their extra stability of construction, we must not forget that the position second only to actual utility is held by beauty and propriety of form; and we agree with Mr. Denison, that "owing to the influence of light, the outside depth is of fifty times more consequence than the inside." "Architects know very well the importance of deep shadows in the outside of their windows; for in the perspective views of churches to be built, which they prepare for the captivation of their clients, they take very good care to give them depth enough."

After a lengthy examination of the characteristics of window tracery in the several styles, and some references to other component parts of churches, the author treats of general arrangement, strongly condemning a too frequent modern practice of seeking ambitious results rather than adhering to simple requirements. Of course, he means, that as ecclesiastical edifices are of different kinds, erected under various auspices, and, in a secondary sense, for different purposes, the proper individual character should be preserved to each, not so much in ornaments as in general feeling. "Accordingly," he writes, "in small churches or in churches where they want as much space as possible for a small sum of money, I think a central tower is a mistake; and it generally looks like an ambitious attempt to copy a large plan on a small scale. Many modern architects have got into the habit of making up little churches for five hundred people, of as many separate parts and with as many different roofs as a cathedral; and parsonage houses in the same way, with nothing but ins and outs and ups and downs, and fireplaces in the outside walls in order to show the chimneys all the way up, and keep the garden warm!"

Some valuable pages are next devoted to the study of Towers, both in point of outline and construction, and the question of the comparative uses of buttresses to them, as exemplified in sundry specimens at home, with their rarity or sometimes total absence abroad, as in some parts of Italy which are so extolled by Mr. Ruskin. In conclusion, all these statements are brought to bear on the primary subject, Doncaster Church, and the difficulties which arose from the investigation of the ruins of the former building, as to what or how much of the remaining fragments should be taken as a foundation of the new design. The original idea was, to rebuild the church wholly in the Perpendicular style; but so many curious indications of earlier work were discovered among the ruins, that the matter was re-considered, and it was eventually decided "to adopt at once that style which preserves the leading features and character of the older church, and is in itself the best;" that is, the Geometrical, or Early Decorated, as it is more usually termed.

The delivery of these lectures has doubtless proved serviceable to the cause intended, and their perusal is calculated to benefit not merely the uninitiated, for whom they were more immediately intended, but also those embarked in the profession itself who may not be too old or too wise to learn.

A Collection of Problems in Illustration of the Principles of Theoretical Mechanics. By WILLIAM WALTON, M. A. Trinity College, Cambridge. Second Edition. Cambridge: Deighton. 1855. 8vo. pp. 566.

An Elementary Treatise on Mechanics for the use of Junior Classes at the University, and the Higher Classes in Schools; with a Collection of Examples. By S. PARKINSON, B.D., Fellow and Tutor of St. John's College. Cambridge: Macmillan. 1855. Crown 8vo. pp. 288.

Of some branches of science an adequate knowledge may be obtained by learning established principles merely; of others, the knowledge is necessarily crude and imperfect, until developed by a habit of applying those principles. In other words, it is enough to learn the *book-work* of some subjects, while of others mere book knowledge without a facility of working problems is of little avail. Now, no branch of science comes more clearly into the latter category than Mechanics. We might almost venture to say that the student's real knowledge of Mechanics is to be measured by the number of problems he has worked in it; for one mistake that is made from sheer ignorance of mechanical principles, a hundred are made from inexpertness in applying them. Point out to the student a blunder which he has committed in a mechanical problem, and the probability is, that he will almost immediately recognise his own error.

The same remark applies with respect to Practical Mechanics. With all the crude notions which are afloat among the class vaguely called "practical men," there is frequently great vigour of comprehension of the action of physical forces, so that a person of mechanical genius unaided by scientific knowledge is often able to form a rough estimate of the power of a complicated engine. And yet we know by experience, that most disastrous

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consequences have followed from over-sights of such men. They have neglected the existence of some force or some mechanical condition, which they recognise the moment the omission is pointed out. We have had experience, in connection with this *Journal*, of several inventions for perpetual motion, or otherwise manufacturing power out of nothing. On examining these inventions, we have in every case found that the inventor has totally omitted to consider the existence of some force destructive of the efficiency of the machine, and we have in every case satisfied ourselves that the error arose, not from lack of knowledge, but from inexpertness in applying it.

We are ready to admit that much useful knowledge may be derived from a study of treatises on engineering, but that knowledge needs to be exercised and applied by original investigation before it can be of much practical use. Such books are merely gates of knowledge; the investigator must make his own way when he has entered by them.

Of all collections of worked problems of Theoretical Mechanics, that of Mr. Walton is beyond a doubt the best existing. Indeed, we are not aware of the existence in this country of any other considerable modern collection, which pretends to a rivalry with this. The design of the author has been to facilitate the study of Theoretical Mechanics, by illustration of all the more important principles of both Statics and Dynamics. In treating of the former, Mr. Walton gives a very copious selection of examples relating to the equilibrium of particles, rigid and flexible bodies; working out the greater number of examples, and leaving the rest, with the answers merely given, for the exercise of students. A distinguishing feature of the selection is, that it consists, in a great measure, of problems possessing historical interest, either from being connected with some great discovery in science, or from being the subject of remarkable controversies, or from being propounded by very eminent mathematicians.

The part of the work relating to Dynamics is treated similarly to the preceding. More care perhaps is requisite in enunciating Dynamical than Statical principles, and accordingly we find in the account at the commencement of each chapter of the principles intended to be therein illustrated, a very careful enunciation of them. The accompanying historical remarks on the gradual establishment of those principles not only give an interest to the study of them, but serve to warn the student of the errors that he is most likely to fall into respecting them.

Several additions and improvements are made in the second edition. As far as our own judgment is concerned, we should have been inclined to have increased the space devoted to problems on the general principles respecting Vis Viva, &c., as certainly more dynamical problems are solved by those principles than by the general equations of motion.

The object of Mr. Parkinson's treatise is the elementary exposition of the principal theorems of Mechanics, so far as they can be investigated without the Differential Calculus. The mathematical knowledge required of the student of this treatise, is confined to Euclid and elementary algebra and trigonometry. This manual possesses, in an eminent degree, the merits of perspicuity and accuracy; and evinces itself to be the work of a mathematician who is not only practically cognisant of the ordinary difficulties of students, but who well knows how to deal with them. The treatise is an excellent manual of the principles of Statics, and of the Dynamics of Particles, and its value is increased by the addition of a useful collection of examples.

We quite concur in the remark (p. 157) that the "Laws of Motion" cannot be proved experimentally of particles, because mathematical particles are not susceptible of being experimented upon. But we go a step further, and assert that the experiments usually cited as evidences of the Three Laws of Motion, do not even *suggest* them. Take, for instance, the First Law,—That a particle in motion, and not under the action of force, will move uniformly. This, in our view, is a mere inversion of the definition of *force*, the cause of motion. But how is it attempted to be proved?—By reference to the fact that a stone thrown along different surfaces will *cæteris paribus* come to rest the rougher they are. Now, how is their relative roughness estimated? It must be *statically;* for to say of one of the surfaces that it exerted dynamically greater retarding force than another, would be to assume the very conclusion which the experiment with the stone is intended to prove. That experiment, therefore, suggests, not the First Law of Motion, but something quite different—namely, that the greater the statical, the greater also is the dynamical friction of surfaces.

Similar objections may be taken to the so-called proofs of the other two Laws. Either a gross *petitio principii* must be resorted to, or the experiments prove something quite different from what is intended. The truth is, that the attempt to prove experimentally, properties of things not susceptible of being experimented upon—*i. e.*, material points which have no physical existence—is one of the most glaring defects of modern treatises. Newton very properly called the Laws of Motion, *Axiomata*.

It seems to us that all the theorems, both of Statics and Dynamics, respecting "particles," ought to be proved without a single reference to experiment. Experiment is wanted only when those principles are extended to bodies, and are so wanted to eliminate in some cases, to ascertain in others, the effect of molecular forces. D'Alembert's principle eliminates them in the most general manner; and the Three Laws of Motion, as applied to finite bodies, are particular cases of that principle.

Rustic Adornments for Homes of Taste. By SHIRLEY HIBBERD. London: Groombridge and Sons. 1856.

The occupants of our suburban villages have generally a great desire to decorate their grounds with various tasteful ornaments, but with all due deference to such praiseworthy desire, we cannot always admire the taste displayed by them; indeed, their business habits too often deprive them of the opportunity of obtaining their fair share of æsthetical education for this purpose, and we therefore too frequently observe a puerile style of decoration, emanating generally from the taste of the gardener, and therefore not always the most refined. There are, of course, many exceptions to this rule, and we sometimes see great taste displayed by the wealthy owners of some of these pretty grounds. It is with a view of assisting those who are deficient of these qualities that the present little work is published. It treats upon the various adornments of a garden, commencing with the "Aquarium."

"The aquarium is one of the latest and choicest of inventions for the rustic adornment of a home, and affords, at a comparatively small expenditure, an immense return in the way of instruction and amusement. Its very difficulties enhance its power of interesting, and add a zest to the enjoyment of success. Considered as a domestic ornament it is insurpassable, and while in its humblest form it presents a constant succession of beautiful and novel objects, so to all the accessories of artistic decoration, it adds the charm of life in some of its most beautiful and strange developments. The merest glimpse of water is always refreshing to the eye; its clear, cool aspect, the mingling of many colours and forms; the peculiar growth of aquatic plants, and the still more curious forms and movements of aquatic animals, combine to form an assemblage of delightful and ever-changing pictures.

We used to study the tenants of the sea by means of wretched specimens, shrivelled up in spirits, or crushed flat between the pages of books. Occasional festoons of sea-weed suspended from the ceiling, or set out upon the mantel, so as to absorb every stray wisp of smoke; a few corals and madrepores, and occasionally a queer-looking stuffed fish, the shape distorted and the colour gone, have long marked the extent of the means for the domestic study of 'deep sea wonders;' while the ill-arranged specimens in the British Museum have, for years, been little better than such collections as superannuated sailors delight in, for awakening or directing public attention to a class of creatures having so few analogies to those of terrestrial origin.

The aquarium exemplifies, in an instructive manner, the great system of compensation which, in nature, preserves the balance of equilibrium in animal and vegetable life. Indeed the recent adoption of this plan of studying the characteristics of creatures hitherto placed beyond our reach, except when dead and mutilated, has arisen out of the experiments of philosophers as to the nature of that duality of forces which render the two great departments of organised existences essential to each other, not merely for ordinary sustenance, but for the continuance of refined chemical operations essential to their respective organisms. Researches into the chemistry of animal and vegetable bodies, and especially of the effects they severally produce, by respiration, on the medium surrounding them, have resulted in the conclusion that animals and vegetables supply each other with the gases most essential to existence; what the one exhales as effete and obnoxious, the other absorbs for the highest uses of vitality. Animals take oxygen from the medium in which they live, and in return exhale carbonic acid. Vegetables also absorb oxygen gas, and give out carbon; but they also absorb the latter in greater quantity than they exhale it, and during their season of greatest activity throw off more oxygen than they take up at other times. Herein is the first element in the management of an aquarium, which, to be successful, must contain a sufficient number of plants to supply the animals with atmospheric air for respiration."

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A general history and description of the various kinds here follows, with the construction and method of furnishing, which will be found particularly interesting and useful to the naturalist.

The "Wardian Case," also, receives its due share of attention, and Mr. Ward's system of forming and planting them is fully described.

"In the furnishing of glazed cases, it must be borne in mind that they are not equally suited to every kind of vegetation. Plants which thrive on dry sands, where rain seldom reaches them, are by no means so fit as those which love shade and moisture. Most bog-plants, such as the different species of *Drosera* and *Pinguicula*, and the lovely grass of Parnassus, and a large number of those plants which the townsman dare not expose for a week in his smoky garden—the choicest flowers of spring—grow freely and bloom well in them. Primroses, snow-drops, crocuses, wood-sorrel, and ferns of all kinds, the smaller being of course the most appropriate, besides, fairy-roses and succulent alpines are well fitted to aid in the display of verdure and colour, which is the triumph of the invention."

Then follow descriptions of vases for cut flowers, miniature plants, the aviary, and various other useful and ornamental furniture for the garden and conservatory.

The little work is got up in good style, has many well executed wood-cuts and several coloured plates, and forms a suitable book for the drawing-table.

Examples of Building Construction. By HENRY LAXTON, Architect. London. 1856.

The Second Division of this work is just published. It contains sixteen large super-royal plates, of very useful details.

The first plate (numbered 17) has several examples of plinths, panellings, and skirtings, from the designs of Philip Wyatt; and the second (No. 18) exhibits some fire-proof floors from the same architect, but although useful as examples, we should, perhaps, scruple to follow them at the present day. Plate 19 has some trussed girders by Wyatt and Atkinson, which may be useful to the student.

Plate 20 has a drawing of the scaffolding, of whole and half timbers, used by Grissell and Peto, in raising the Nelson Monument, which may prove serviceable to those likely to be engaged in similar structures.

Plates 21, 22, 23, comprise elevation and details of an iron shop front, at Maidstone, which for novelty and peculiarity of design deserve attention. The front is full of enrichment of a character more curious than beautiful. The one-pair floor has a range of compartments separated by twisted columns, having an enriched entablature, surmounted by balls and spikes, and filled in with plate-glass windows. The ground-floor contains a series of foldings doors with ornamented horse-shoe heads, and sashes, having large squares of plate-glass, occupy each side. The brickwork of the upper floors is covered with Minton's tiles, and the whole crowned with a rich bracketted cornice, composed of iron, stone, and terra-cotta. The houses were old, the front wall being rebuilt and faced with new work. The architect, Mr. Whichcord, has shown much ingenuity in putting together the work, the details of which are here clearly given to a quarter real size. Plate 28 shows the system of lighting and ventilating applied to the same building. The burner is fixed within a ground glass globe, the upper portion of which is cut off to admit a bell-shaped glass, covering a straight chimney over the argand burner; an iron pipe fitted into the top of the bell conveys away, through pipes in the floor above, the heat and effluvia arising from the gas. Another example shows a sunlight fitted into an iron frame or receiver, filled with ashes, from the top of which an iron pipe is taken through the floor as in the former case. A rusticated porch, by Smith and Thurston, architects, built to Clinton-house, Weybridge, has a striking and novel effect; the treatment of the coupled pilasters, with rusticated stones running through them, give much play to the design.

The plate of masonry, No. 26, (Philip Wyatt, architect), has some useful hints. It consists of a portion of a rusticated ground story, with two circular-headed windows; the details to a large scale show the way of bonding the ashlar to the brickwork. This is done by a T-shaped cramp, the cross part of which is dovetailed into the front stone, while the blade is perforated with a round hole, and rides over a pin fixed into an inner bond stone, built separately from the ashlar, upon the brickwork. A cavity is left in the brickwork to allow play to the pin, which goes down with the brickwork when it settles, and leaves the ashlar unmoved. The way of setting the key-stone is also clearly shown, as well as other portions of the mason's work.

Sections are shown of the new church at Charlton, Kent, Messrs. Gwilt, architects; wherein the hammer-beam roof and gallery floor are given to a large scale, and show some novelty of treatment.

The grand staircase at Wynyard—the late Philip Wyatt, architect—is shown with several of its details. A short flight of steps, approached through a cluster of four verd-antique columns, with statuary capitals of the Ionic order, rises from the centre to a landing, and there divides into two flights, one against each side wall, till it reaches the upper story. The walls and columns are of scagliola, and the steps of Portland stone. There is much that is useful in this plate, and, with the one that is to follow in the next Part, will form excellent data for the construction of principal staircases.

A roof with molded tiles to Walton House (Sir Charles Barry, architect,) furnishes the next plate, with the cornice and concealed iron gutter. The pitch of the roof is very flat for tiles, but the simple way in which one tile fits into the other, each being semi-circular and smaller at one end than the other, secures it from the weather. Then follows a plate, which concludes the set, containing three roofs, and a pair of yard gates, erected at Rotherhithe, under the direction of J. Gwilt, architect, the details of which will be found serviceable.

The tendency of this practical work is to offer examples of the various modes adopted in construction by many of the most eminent architects, and to diffuse such knowledge of skilful application all over the kingdom, which must particularly benefit those who are confined nearly all their lives to one locality and one style of practice.

Details of Gothic Architecture. By J. K. COLLING, Architect. 2 vols. 4to. London: Bogue.

(*With Engravings, Plates* X. *and* XI.)

Being enabled, through the kindness of the proprietors, to again enrich our pages with some further specimens of the plates contained in this exceedingly useful publication, we cannot refrain from availing ourselves of the permission. Our plates, X. and XI., are from the Norman and Early English portions of the work, exhibiting interesting remains of the cloisters of Boxgrove church, Sussex; and some fine bosses, of peculiar character, from the groining in the aisles of the same edifice. The church at Boxgrove, from which these subjects have been obtained, is partially decayed, as the plates indicate. It was an appendage to the ancient priory founded by Robert de Haye, about the time of the first Henry, it being a cell to the convent of Essay in Normandy. Since the Reformation it has become the parochial church, and though time has limited its space, it yet consists of transepts, nave, two aisles, and three chancels; and in early times, numbered among its benefactors the rich and powerful William de Albini, Earl of Arundel, husband of Henry the First's widow, who is said to have been buried beneath one of the altar tombs. Edward III. naturalised the priory foundation from all the disadvantages it was subject to as being alien. We merely mention these historical facts in connection with the monastic institution, to show the importance once attached to it. The author, Mr. J. K. Colling, to whom the architectural profession owes much for his elaborate work on 'Gothic Ornament,' has fairly fulfilled all the intentions he held forth at its commencement. The plates will number no less than 180, and embrace every variety of detail, useful as data to the Gothic architect engaged in church erection, for which purpose the work was mainly undertaken. The subjects evince great judgment in the selection, for there is scarcely a plate given but may be considered good in design, striking in effect, and worthy of being followed, and can only have been obtained with much labour and research. In the execution of the plates, Mr. Colling has been well seconded by his colleague, Mr. Jobbins, who has rendered them with great clearness and considerable care. We recommend our professional brethren to give these volumes a fitting place by the side of the author's work on Ornament.

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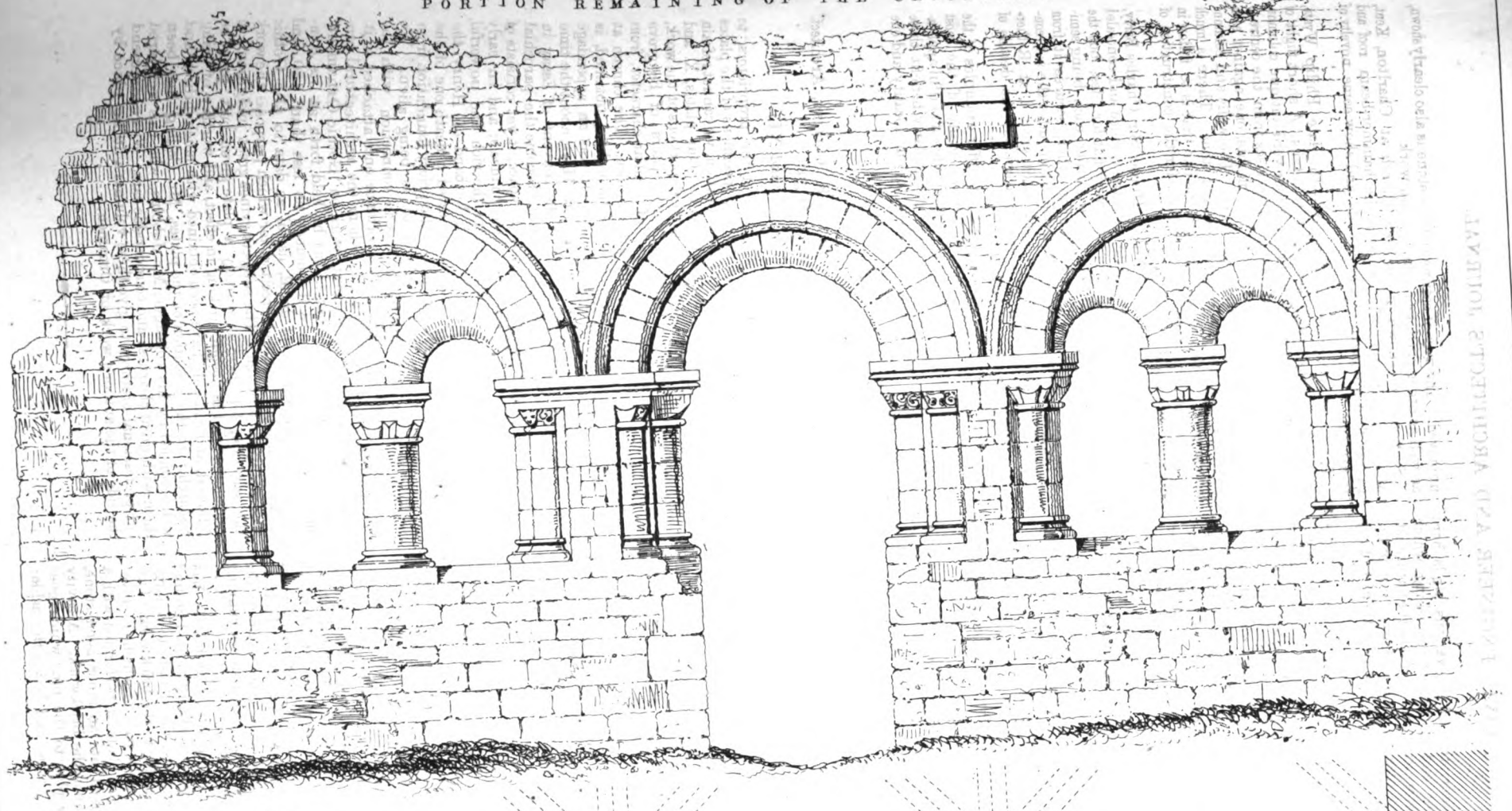
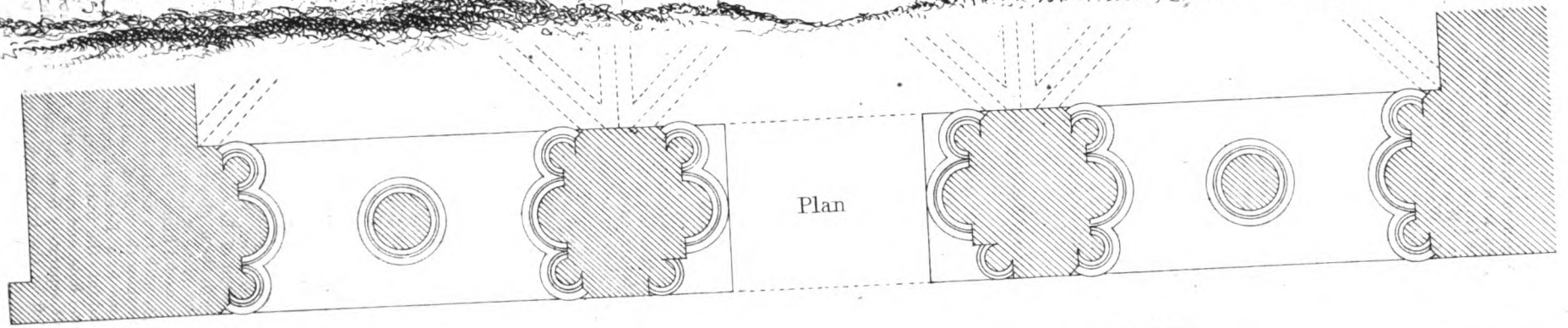
BOXGROVE CHURCH, SUSSEX.
PORTION REMAINING OF THE CLOISTERS





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J.K.Colling, del.

J.R.Jobbins.

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BOXGROVE CHURCH, SUSSEX.

BOSSES FROM GROINING OF AISLES.

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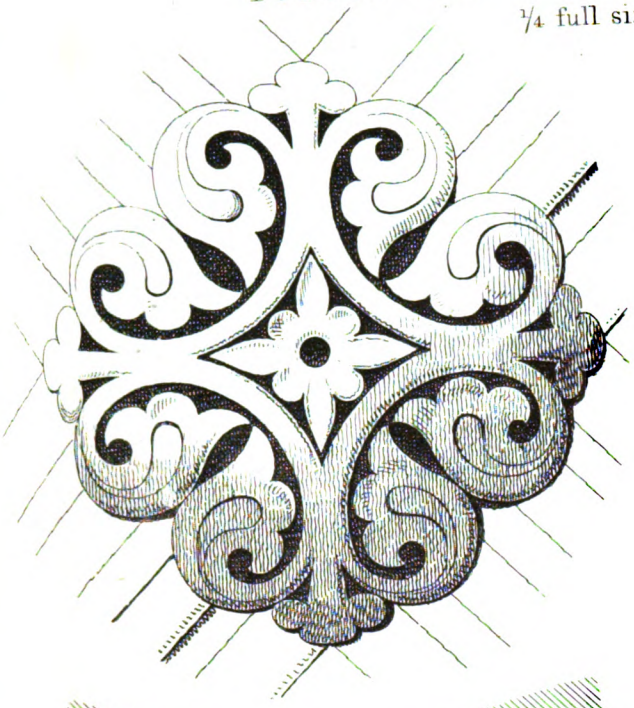

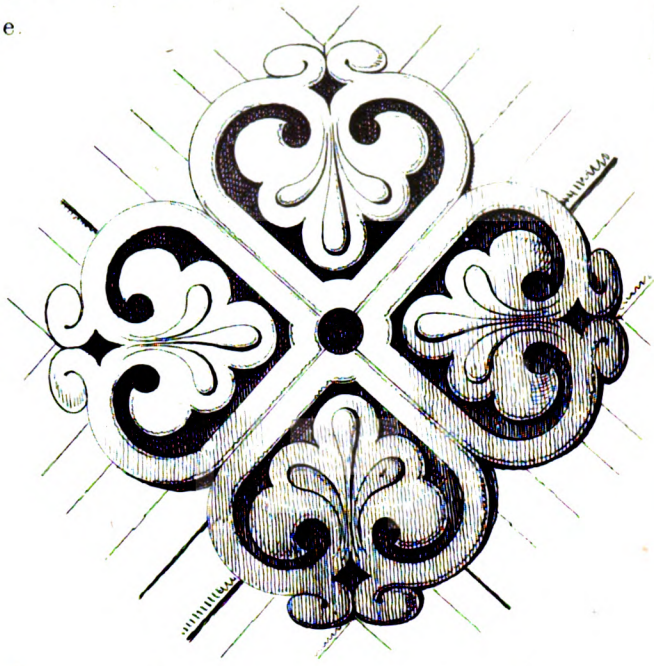

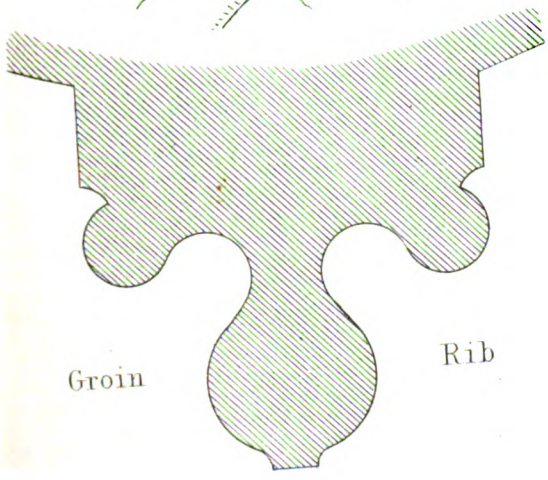

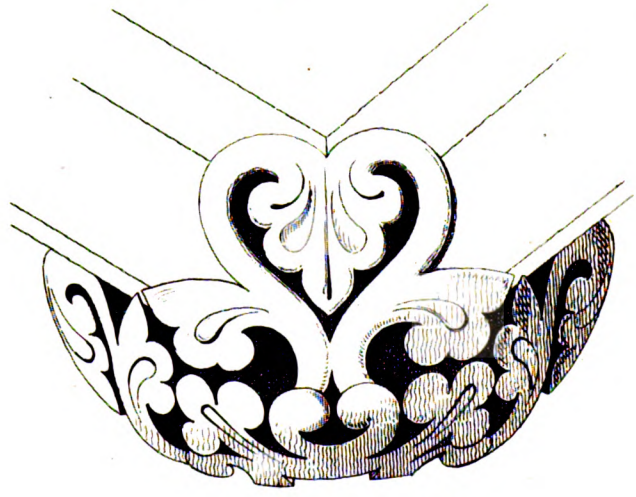

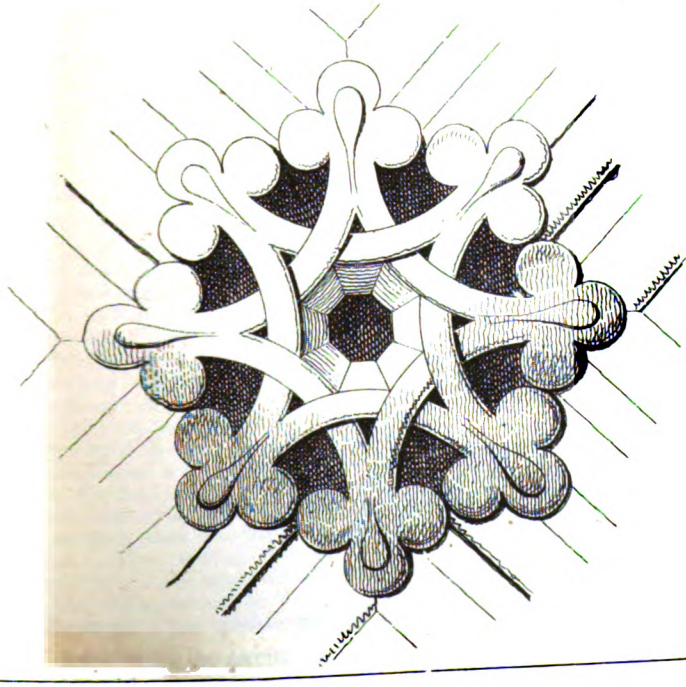

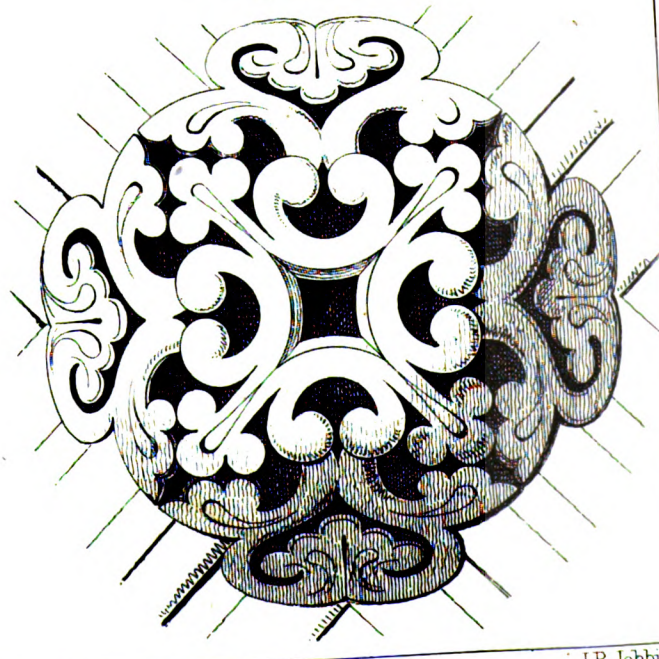

J.K.Colling, del.

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SOUTH AUSTRALIA, AND ITS PUBLIC WORKS.

By W. Bennett Hays, C.E.

The province of South Australia, which was founded in the year 1838, is contained between 26° and 38° of south latitude, and between 132° and 141° of east longitude. It is bounded on the north and north-west by the waste and hitherto unappropriated land of the interior; on the east by the colony of Victoria, formerly known by the name of Port Philip; and on the south and south-west by the Southern ocean.

The climate is characterised by the extreme dryness as well as purity of its atmosphere. The rains are periodical, commencing about the month of April or May, and continuing throughout the winter and part of the spring months. Very little rain falls in the months of December, January, February, and March; during which time the face of the country presents an arid appearance, the herbage, which in the winter was green and flourishing, now almost entirely disappearing. From this extreme dryness, bush fires are of frequent occurrence, and are at times very destructive, spreading over many miles of country at a time.

The temperature during the summer commonly ranges between 70° and 90° Fah., but occasionally during hot winds attains to 110° or 112° in the shade, and as much 135° in the sun. In winter the thermometer seldom falls below 40°, excepting in the hilly districts, where occasionally during the night thin ice is formed.

This fine and flourishing colony, which, until within the short period of seventeen years, lay swaddled in its primeval forests, untrodden save by the kangaroo, the wild dog, the emu, and the wandering aborigine, himself scarcely raised by his low intellectual development a grade above the inferior tenants of the uncultivated wilds, now teems with an active and intelligent population of about 93,000 souls, who, in the actual possession of 1,000,000 acres of purchased land, and in the occupation of 10,000,000 more under the tenure of pastoral leases, and contributing an annual revenue of upwards of half-a-million sterling, are rapidly developing the unbounded agricultural, pastoral, and mineral resources of the land of their adoption.

Already is the population of this new colony beginning to avail itself of such of the most approved appliances of modern engineering as are calculated, by affording the utmost facilities for communication by land and sea, to promote rapidly the material prosperity of the colony, such as railroads, the electric telegraph, coast and harbour works, and internal navigation improvements.

In bringing before the notice of engineers accustomed to the consideration of the vast, costly, and highly elaborated works of a great empire in the meridian of its wealth and power, the operations of an infant colony, it is not to be expected that much possessing either intrinsic merit or novelty can be offered. A certain degree of *rough* and *readiness*, to use a homely expression, consequent upon limited means and appliances, will be the prevailing characteristic.

The interest attaching to this slight record of early efforts will be rather a *retrospective* one, at that time when, in all human probability, these small beginnings shall have grown up into the substantial and enduring results of a wealthy and powerful community.

The operations of common road making may deserve first a few remarks.

Common Roads.

The principle which has been adopted for the alienation of the crown lands of the colony is that of its being required that they should in the first place be offered for sale by public auction, at the uniform upset price of 1*l.* per acre, without reference either to position or relative value. All lands, other than townships, which are laid out in quarter-acre to acre allotments, have been accordingly divided for the most part into blocks of eighty acres, generally in squares or parallelograms. Lines of main roads, connecting the principal parts of the colony, having been first selected, the *sections*, as the eighty-acre blocks are called, were then divided out in the intermediate spaces, having district or accommodation roads between them, so arranged that, if possible, no section should be without a road frontage on at least one of its sides. The country is thus intersected throughout by roads running for the most part in strait lines, parallel to, and at right angles with, each other.

Owing to the careless manner in which some of the earlier surveys were made, many of these roads are found to be laid out without any regard to the natural features of the country they were designed to traverse, being marked indiscriminately over impassable acclivities or precipitous ravines. This, of course has entailed much needless trouble upon those who have afterwards had the formation of these roads; requiring re-surveys for effecting deviations in order to avoid needless expense, or to secure the possibility of construction.

In the earlier years of the colony the roads, as well as all the other public works, were under the sole management of the Surveyor-General for the time being. But, as these operations increased in magnitude, the formation of distinct departments for the superintendence of the various kinds of work was found necessary, and the construction and maintenance of the main lines of road was entrusted to a commission called the Central Road Board, which appoints its own officers, and has control of the funds appropriated for this branch of the public service. These funds are derived from the proceeds of the sale of crown lands, one moiety of which is devoted to public improvements within the colony, and the other to the promotion of immigration from the mother country.

All roads, not being *main lines*, are under the control of district councils, the members comprising which are elected by the ratepayers of the several districts, and whose funds are derived from an assessment of the lands.

The general surface of the ground in this country, where it has been subject to no artificial disturbance, is found to be for a depth of from 1 to 2 feet, as hard in the dry season as an inferior burnt brick; and even in wet weather, where it lies well for drainage, it is capable of bearing, in this its natural condition, a very considerable amount of traffic without becoming seriously impaired. But when once this crust is worn through, it immediately assumes the form, during the winter season, of sloughs and quagmires, always offering serious impediments to, and sometimes entirely arresting traffic. In the dry summer months the inert mud assumes the form of a mobile and almost impalpable dust which, under the influence of the frequent winds, is carried aloft and spread over the country in dense and everywhere-penetrating clouds, which sometimes for hours together utterly obscure whole districts, and form one of the most serious annoyances to which the inhabitants are exposed.

If it had been practicable for this natural crust to be availed of as a foundation, a moderate thickness of metalling, combined with judicious drainage, might have formed an excellent road at a very trifling expense. But it has generally happened that the means at disposal for road-making have failed to keep pace with the requirements of a rapidly increasing traffic; the consequence of which has been that the *natural* road has been generally cut up, and the formation of the artificial one urgently needed, long prior to the time when such was practicable.

But even when such was not the case, it does not appear that those who have been entrusted with the business of road-making have ever thought of taking advantage of the ready-made, hard substratum provided by nature for their roads; but, following implicitly the established precedent of old countries, have invariably commenced by cutting up the solid crust in order to give the base of their road the form of section recognised in such cases. And this error has in some instances been carried so far, that several miles of *formation* have thus been made before any metalling was at hand to cover it; and, being left in that condition for a whole winter, soon got into an infinitely worse state than if nothing had been done to it.

The method of road-making at first adopted in some parts of the colony, was that of first laying a coat of pitch paving, about 9 inches to 1 foot thick, of stones rough from the quarry, hand set, with the broad base downwards, and a top coat of 6 inches of metal broken to a 2½ inch guage. This method was found to be very costly, and the pitch paving, if not set with the utmost care, which it was impossible at all times to insure, was found gradually to work up through the metalling. The plan generally in use now, is to spread first a course of 9 inches of metalling broken to a 4-inch guage, and then a top coat of 6 inches to a 2½-inch guage of a harder quality.

In situations where it is easily procured, a sort of siliceous limestone, of a somewhat friable nature, is used, and forms an excellent first course, as it binds in a short time into a very firm consistence. This peculiar limestone formation is very extensive throughout the colony, particularly on the plains and more level country. It exists in the form of a superficial crust, of a thick-

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ness varying from 9 inches to about 2 feet. It varies much in hardness and in the relative proportions of sand and lime. In some places it covers the surface, immediately under a thin layer of vegetable soil, over extensive districts. In others it exists at a depth of several feet, where it appears in the beds of creeks and rivers. Besides its value for road-making, it is used extensively as a building stone, laid as rubble work, in buildings of an inferior character. It makes also, when burnt, excellent lime for mortar.

In the hilly districts, road metal of the best quality is procurable in the greatest abundance.

Sixty-six feet is the uniform width reserved for all roads throughout the colony. It has been customary to make the *formation* width about 42 feet, in the centre of which the metalling is laid to a width of 22 feet, the sides or water tables being left in the natural soil. Beyond these, and within the boundary of the 66 feet, the side ditches for drainage are usually formed.

The climate and the peculiar character of the soil combine to render the operation of surface-drainage a costly and troublesome one. During the summer the soil, which, except in the hilly parts, is generally a light sandy loam, becomes much parched by the dry heat. The winter rains, descending in torrents, quickly fill the ditches, creating in a short space of time a great rush of waters; these, acting upon the already disintegrated soil, rapidly degrade it, and the result of the labour of a whole season is often seriously impaired in a few hours. The side drains derive little or no assistance from the growth of vegetation within them, the roots of which might serve to bind the soil; for the growth of the wet season is almost annihilated by the scorching heats of the summer, and thus there is no accumulation of vegetation from year to year. For this reason the operation of sodding with turf can scarcely be resorted to with any good effect.

The water, acting upon the bare and arid sides of the ditches, commences by excavating and removing the lower portions, gradually hollowing out large cavities; as these are formed the upper portion, losing its support, falls in, and is in its turn removed. And this action often goes on so rapidly that in the course of one or two seasons, on ground having any considerable slope, a surface drain originally cut but a few inches in width will present the appearance of a huge chasm, some 12 or 15 feet deep, and 6 or 8 feet wide at the top. This may appear scarcely credible, but it is a matter of not infrequent occurrence.

It may naturally be asked why a remedy for this is not at once adopted, which, if applied in time, might prevent all the mischief. The answer is, that the limited resources of a young colony are insufficient to do more than provide for some of its most urgent wants. If one part is to enjoy the benefit of a liberal expenditure, others must suffer from the want of it. Where the cry for assistance is heard at once from all quarters, each must put up with what little can be got, and make the best of it. Much waste and ultimate loss is, doubtless, entailed by this forced system of half measures; but time alone can bring an effectual remedy.

In most instances, probably, the only efficient mode of forming side drains to roads would be to pitch-pave or otherwise line them with stone, bricks, or tiles; but the heavy outlay in first cost precludes this, and thus a most disproportionate expenditure becomes afterwards incurred for maintenance.

Hitherto the cost of common road-making has been defrayed only from the current resources of the colony. It is very questionable whether the system of raising large sums by way of loan, and thus insuring the formation in the first instance of substantial and durable works of this kind, would not be far better policy than that of literally sinking annually, as is done, comparatively smaller sums in works so inefficiently performed as to be a source of far greater ultimate expense, besides imperfectly attaining the end for which they were designed.

A feeling on the part of the colonists, adverse to the formation of anything in the shape of a national debt, has made them overlook in this matter the true interests of the community. The principle, however, is now beginning to be recognised and acted upon, in reference to railroads and other reproductive works, of which more particular mention will be made in a future portion of this paper.

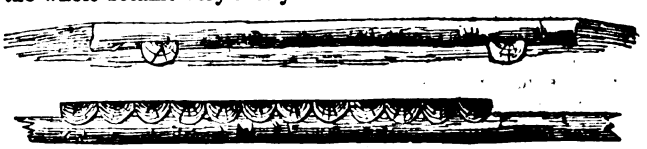
Of the actual cost of road-making in this colony, little of a definite character can be said. It is subject not only to great variation from locality and facility of procuring material, but also from the fluctuation in the value of labour. Since the discovery of gold in the Australian colonies, labour has been extremely high, and road-making has necessarily partaken of the increased cost of every other product of labour. Labourers employed on this description of work have lately received from 8*s.* to 11*s.* per day.

Tolerably good and substantial metalled roads are now in existence on the principal main lines for 10 or 15 miles out of Adelaide. And in one or two directions, very passable roads exist for about double that distance. But all beyond this, as well as the intervening district roads, remain pretty much as nature has made them.

While on the subject of roads, mention may be made of an attempt by the author to introduce a formation somewhat analogous to the *plank roads* of America.

In constructing one of the numerous jetties that have been lately erected on different parts of the coast, the approach had to be made for about a quarter of a mile through the deep sand-hills that bound the coast almost everywhere upon the low-lands. This spot was chosen for the experiment as being likely to afford a good test, where from the extreme lightness and looseness of the soil, a common road would have been made with some difficulty, and also as timber was abundant in the neighbourhood. An excavation was first made through the sand-hill to the proper level, and, without any further preparation, the plank road was laid down, constructed as follows.

Two longitudinal pieces, formed by sawing down the middle round rough logs, of a diameter not less than 7 inches at the smallest end, were first bedded in the sand, with the flat sawn side upward, halved and spiked together at the joints. These extended the whole length of the road, and served the double purpose of bearers and connecting pieces for the superstructure. This consisted of similar sawn logs laid transversely upon the longitudinals, also with the flat sides upwards, and side by side as close as could be to one another; for which purpose the rough edges were trimmed so that the adjoining surfaces should generally have a width of not less than 2 inches on the face. These transverse pieces were spiked to the longitudinals, with two spikes at each point of intersection. In laying the transverses or planks, care was taken to ram the sand well under each, so that the whole road might bear evenly upon the foundation. Sand was afterwards strewn upon the surface, and after a little traffic the whole became very nicely consolidated.



The road was made for a single track only. The planks are 10 feet long, making the road that width. The timber used was the eucalyptus or red gum. The white ant, which abounds in the colony, does not readily attack this timber.

This road has been laid about a year and a half, and appears to stand well, being almost as light for traffic as a tram road, and giving sufficient foothold for the bullocks, which are the principal draught cattle in use in the country districts. The following are the particulars of its cost.

Cost of each slab, 10 feet long, and averaging 6 inches wide when laid:

	s.	*d.*
Felling and carting to saw-pit	1	2
Sawing	1	0
Carting nine miles to the work	1	3
Labour and nails .....laying	1	8
Total	5	1

Being about 6*d.* per foot lineal for the planks, and the same for the longitudinals; or at the rate of about 2900*l.* per mile of a road or track 10 feet wide.

It must be borne in mind, that the wages paid at this time for common labourers were from 9*s.* to 11*s.* per day, and also that the amount of actual work performed by each man was generally somewhat in the inverse ratio of the extravagance of the wages he received. Such is one of the drawbacks that a young colony has to contend with.

Bridges.

The subject of roads leads naturally to that of bridges. But before entering upon these, a few general remarks on the inland waters of the Australian continent may not be out of place.

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One great characteristic of this new country is its almost total absence of rivers, at least of anything deserving the name: a feature in which it contrasts in a striking manner with the former new world, discovered by Columbus, a land whose rivers are inland seas.

Among other remarkable, and almost paradoxical features in the natural history of Australia which attracted the attention of early explorers, was that of its rivers—what few it had,—which appeared to pursue a course contrary to that suggested by the experience of other countries, in most cases taking their rise near the coast, and, instead of flowing direct toward the ocean, running inland, where they appeared to be dissipated among morasses; and in cases where they eventually reached the ocean, instead of discharging their waters into it through a progressively widening and deepening channel, became lost amid bars and shoals. And this condition of the Australian rivers is to a great extent the actual one. It may be accounted for by the natural features and climate of the country.

The hilly and mountainous districts are for the most part confined to a belt near the coast, while the interior consists principally of vast plains, having but a slight elevation above the sea. The rivers which have their source among these high lands are fed by the periodical rains of the winter months. As during the summer months little or no rain falls, the sandy, and to a great extent barren, soil of the interior is exposed for the whole of that period to the scorching rays of the sun, aided by the excessively dry atmosphere and the frequent occurrence of hot winds; the consequence of which is that the waters brought down by the smaller streams, which drain but a limited area of country, are insufficient to extend their course for any great distance over the plains, and very soon assume the form of mere inundations over level tracts of the low-lying ground, which, before the return of the rainy season, are either absorbed by the arid soil or evaporated.

Many of these watercourses are quite dry during the summer season; others consist of a chain of detached water-holes, which have been scooped out from time to time by the winter torrents; while the few that are perennial are in the dry season mere driblets.

For the same reason, those rivers which reach the sea have, with few exceptions, no direct communication with it during the summer months. At that period the force of the land waters is insufficient to keep a channel open through the bank of sand which the waves throws up across the mouth.

In the summer time a person might frequently, in walking along the sea beach, pass without noticing it, the mouth of a river at a spot where, in winter, he would find himself stopped by a wide and deep channel, through which the flood waters were rushing with the greatest impetuosity.

The river Torrens, which passes through the city of Adelaide, and whose waters never entirely cease to flow, has no perceptible channel of communication with the sea. It loses itself in a morass called the Reedbeds, which, though situated within half a mile of the coast, is quite shut in from the sea by a continuous line of sand hills. The waters of the river doubtless escape partly by percolation through the sand, and the rest is discharged through two channels which drain this morass; one of which empties itself into the land-locked water forming the Port of Adelaide, and the other passes direct into the sea at the marine township of Glenelg.

It was this river which, combined with other favourable circumstances, chiefly guided Col. Light, the first Surveyor-General of the colony, in the selection of the site for the city of Adelaide. This city is laid out in two parts, called North and South Adelaide, each standing upon a somewhat elevated plateau, and separated from one another by the valley of the Torrens, which is about half a mile wide. A space of ground of a similar width is also reserved all round the city, called the Park Lands, which can never be built on; an admirable arrangement and one calculated to promote for all future time the salubrity and handsome appearance of the city.

The river Torrens, which is in itself but an insignificant stream, having a total course of not more than 30 miles, has however some striking peculiarities in its present compared with its past condition, in which it is a type of most of the smaller streams of Australia.

The first Surveyor-General, in a report which he sent home of the topography of the city of Adelaide and its vicinity, is said to have described the Torrens as "a river which he could span with his hand, and sound with his finger." It has now in many parts near the town, a channel upwards of 200 feet wide and 20 feet deep, which occasionally for a short space of time, during the winter floods, is known to run quite full. During the dry season, however, Col. Light's description is not a much exaggerated one. A pipe of 12 inches diameter would then certainly carry off all its water.

Before the occupation of the colony, the channel of this river, in common with many others, was overgrown with accumulated vegetation, which protected it from the scour of its waters; these during flood times found space for their passage by overflowing the adjacent lands. But, as soon as the progress of cultivation, the passage of cattle, and other effects of the hand of civilised man, began to operate, the protecting vegetation became gradually withdrawn, and the light sandy soil, being exposed to the winter torrents, began to be removed, and the channel thereby enlarged. And this operation has gone on with astonishing rapidity, as may well be conceived when compared with the similar degrading action before described in the case of road-surface drains.

But little has been hitherto done in the colony in the way of bridge building, if we except the case of the river Torrens. From its position, dividing the city of Adelaide, passages of communication between the two parts were an early desideratum. Accordingly, numerous bridges have been built and swept away again, and the short history of bridge building has been here that of a series of failures.

The early structures were made quite regardless of the peculiarities of the stream they had to span,—of which indeed, at that time, little was known. But even dearly-bought experience was slow to teach, for more than one bridge was put up on principles quite in defiance of the lessons taught by previous experience, only to be carried away again by the first flood.

One of the early bridges was formed on the main line of communication between North and South Adelaide. It was of stone, in a single arch of 60 feet span. It soon appeared that neither sufficient height nor waterway had been allowed. During a flood, a piece of heavy drift timber struck the crown of the arch, and damaged the bridge so seriously that it became necessary to destroy it. The abutment walls were left standing, which soon gave proof of another radical defect in the structure, namely the want of protecting wing walls. In two or three seasons the water had forced its way completely behind and past these abutments, which, thus left isolated, soon ceased to exist.

Five other bridges followed in succession at different times and on different parts of the river. Two of these were for foot passengers only, the others for general traffic. The whole were of timber, and the same principles of construction were observed in all, except one of the foot bridges. This was by driving bays of single piles, braced together to form piers, at distances apart varying from about 20 to 60 feet, and spanned by timber bearers stiffened and supported by cap sills and struts attached to the pile heads, and covered with planking, on which, in some cases, a coating of road metal was laid. No precaution was in any case taken to defend the abutments; these consisted of nothing more than a repetition of one of the bays of piles driven at what was considered a sufficient height up the banks to be beyond the reach of the highest water. Many of these bridges soon became crippled, their own weight, through the intervention of the long struts that were used, forcing out the unsupported abutment piles, and thus allowing the roadway to sag. Only two out of the five are now in existence; the remaining three were swept away (two of them in one night), by an extraordinary flood which occurred in the winter of 1852.

The main cause of their destruction, besides other defects, was that of their being built so low that the flood water frequently passed very near to, and sometimes completely over, the roadway, although this was placed at a height of at least 20 feet above the river bed. On one of these occasions a more than ordinary accumulation of drift timber on the upstream side completely overbore by its weight the framework of the bridge, snapping asunder or tearing up piles of hard wood 14 inches square, and driven 10 or 12 feet into the ground, and carrying all before it.

The foot-bridge mentioned above as an exception to the mode of construction adopted in the others, is one of the remaining ones. This bridge, which was at first formed with a single opening of 60 feet, was then sufficient to span the river. The platform has a width of not more than 4 or 5 feet, of the bowstring construction, the arch being laminated and formed of deals laid together, secured by bolts and straps, and sprung to the

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required curve, which is very flat. The ties are of wrought-iron. It is supported on piers, formed each of two piles, driven a good depth into the river bed, and stayed by raking braces on both the up and down stream sides; these abutting at the lower end upon the heads of piles driven well into the ground and tied across to one another and to the main piles by wale-pieces. The platform is placed at such an elevation as to be out of the reach of the flood waters. Thus there is a clear waterway of 60 feet in width, and ample height; and the platform being so constructed as to exert no lateral thrust upon the supports, these have stood perfectly well.

In this instance, however, as well as in all former ones, no precautions were taken to protect the river bank at the abutments; the rather singular consequence has been that the river, on that side where the *set* of the current is, scoured away the bank to such an extent as to leave the bridge quite disconnected from the shore, but otherwise entirely uninjured. A second arch of similar construction, and the same span with the first, has since been added to fill up the gap; and, further degradation still going on, a third, of rather less span, has been resorted to, the river having increased in that time (a period of not more than three years) from a width of 60 feet to one of upwards of 150 feet. This process might have continued indefinitely, but it was at last bethought to build something like a protecting wall of masonry on this side, to arrest further wearing of the bank.

The operation of protecting the banks of this river is by no means a simple one. The formation through which it flows, in the vicinity of the town, is an alluvial deposit of rather compact sand, alternating with thin layers of gravel, with occasional patches of a clayey nature. The bed on which the river flows at this part is a deep gravel. The channel which it has excavated for itself is in some parts as much as 30 to 35 feet in depth below the general level of the Park Lands which bound it; and its banks have in many places the form of perpendicular cliffs of that height. The whole deposit of the valley seems, indeed, to be due to the river itself, as remains of large trees, which have been embedded at various periods, appear in the banks and bed of the river.

The form and position of these cliff-like banks is constantly changing, as the water undermines and causes them to fall in in large masses; and protecting works, whether of timber or masonry, merely carried up against them, would be always liable to be rendered insecure by the floods gradually removing the loose sandy soil from behind them.

This wearing away of the banks threatens to make very serious encroachments upon the adjacent lands, and the authorities do not appear sufficiently alive to the extent of the evil, to have hitherto organised any measures calculated to arrest a destruction of public property, which every year will render more costly and more difficult of accomplishment.

City Bridge.

Soon after the destruction of the principal bridges in the winter of 1852, the government began to take measures for the erection of what should be a substantial and durable bridge, to connect the two sides of the city. For this purpose they invited designs by public competition. The committee appointed by the legislature to examine these designs, ten of which were sent in, selected one which they recommended for adoption. It was a stone structure, having a single arch of 60 feet span. But before the necessary steps could be taken for its erection, the river had made such further inroads upon its banks, that the plan was found to be no longer suitable; and in the course of the year 1853, the author received instructions from the government to prepare a new design for this bridge. This design being approved, the sum of 27,079*l.* was voted by the legislature for its erection, including the approaches; a premium having been previously paid to the engineer who had made the design recommended by the committee, as compensation for the non-erection of his work.

The foundations for this new bridge were laid during the summer of 1853-4. Particular care was taken to avoid in this work the sources of failure existing in all its predecessors. With this view, the following considerations were principally attended to: *First*, to have sufficient waterway. At the site selected for the bridge, as being most suitable for the convenience of the town, the channel of the river somewhat exceeds 100 feet in width. The bank on the north side is perpendicular, and about 28 feet in height from the bed. The opposite bank is shelving, the general level of the adjacent ground being about 16 feet below that on the north side. From observations made on the course of the flood waters, it was considered that a clear and unobstructed waterway of 100 feet would be sufficient to provide for their safe passage. The bridge was accordingly designed to have a single opening of this span.

The structure being required to be of a durable character, the material selected for the foundation, abutments, and wing-walls, was stone.

The *second* consideration was that of giving to the abutments sufficient stability, consistent with the necessary economy. To do this, it was thought advisable to avoid all lateral thrust, because resistance to that kind of force must have been gained by the mass and weight of the abutments alone, the ground being too insecure to be depended on, beside the possible contingency of the water at some time or other removing that support from the back of the abutments. Accordingly, the arch-form was rejected, and the material adopted for the main support of the roadway was iron, so arranged as to exert only a direct downward pressure, due to its weight, upon the abutments, and placed high enough to leave a clear 14 feet above the highest known flood line.

For this purpose, two main girders of wrought-iron were used, of the bowstring form, with cross-girders of plate-iron for carrying the roadway and footpaths, the latter being outside the main girders and supported on the overhanging ends of the cross-girders. The roadway is formed of timber bearers and planking.

To obviate the risk of the abutments being undermined by the scour of the river, the footing courses of the stonework are laid at a depth of 8 feet below the existing bed, which consists of compact gravel to a depth of at least 24 feet. The footings are carried upon a double course of gum-planking, with sills beneath, resting on the heads of main piles of round timber, driven to a depth of 12 feet. These piles are not absolutely necessary for the stability of the work, but were used as an additional precaution in case of any very considerable and unexpected amount of scour. For which purpose also they are surrounded and enclosed by sheet piling driven 6 feet below the sills.

No difficulty was experienced in forming these foundations as they were got in during the dry season, when the small quantity of water running was easily diverted, and the excavations kept dry by the pumps.

The remainder of the masonry was finished in the summer of 1854-5, the backing to the abutments being filled in and rammed as the work proceeded. The approaches were also made at the same time, which consist, on the south side, of a long embankment over the low ground to bring the roadway up to the necessary level.

These precautions were considered sufficient to guard against any risk of the absolute destruction of the bridge. The *third* and most important consideration was the defence of the banks, in order to prevent the floods cutting off the communication, and leaving this bridge in the same predicament as its little predecessor above mentioned.

This has been attempted by placing the wing-walls, not in the usual way raking back and resting upon the banks, but in a direction parallel with the course of the stream, and carried to a considerable distance both above and below the abutments.

Between the ends of the wing-walls and their respective banks a clear space is left, giving them more the character of *groynes;* the effect of which is that *dead water* is here formed, whereby, instead of a scouring, the contrary action takes place, and the still water deposits the detritus with which it is always heavily loaded during floods, and thus adds to, instead of removing, that portion of the bank where security is most needed.

The foundation of piles, &c., is continued to a uniform depth under the entire length of the wings, as well as the abutments, so as to give equal stability to the whole, and avoid the risk of unequal settlement.

The bulk of the masonry is rubble, of a stone well adapted to that kind of work, being very hard and durable, obtainable in large blocks, and having a good natural bed. The rounded ends of the groynes, as well as the copings, are of tooled freestone.

(To be continued.)

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ON THE MEASUREMENT OF TWO BASE LINES IN FLORIDA, SECTION IV. U.S. COAST SURVEY.

By FAIRMAN ROGERS, C.E.*

THE great importance of extreme accuracy in the measurement of a base line for any extended geodetic operations, calls for an apparatus, which shall overcome the three following difficulties:—

First. The difficulty of determining the exact length of the measuring apparatus with reference to any fixed unit, or to a quarter of the earth's circumference, to which all geodetic distances must be referred.

Second. The avoidance of error from change of length in the apparatus, with variations of temperature and moisture. And,

Third. The very nice manipulation required in the field, to make the contacts or coincidences so perfect that there shall be no chances of error in the practical measurement; a view being had at the same time, to economy of time and labour in the use of the apparatus.

In the operations of the United States Coast Survey, the French metre has been adopted as the unit, its length being more accurately determined than that of any other standard. Its value, as compared with the American standard, is 39·36850154 inches. The metre being at 32° Fahr., and the inches at 62° Fahr. In the outset, this comparison of the metre with the foot, is a matter of great difficulty, owing to the want of coincidence of the several English and American standards.

The difficulty of making a bar of metal so nearly equal in length to another bar as to differ by a quantity inappreciable in a single length, is not very great; but when this discrepancy, however small, comes to be multiplied by one or two thousand, the number of bars in a base line, the error becomes very sensible, it being, unlike most instrument errors, a cumulative one. The method adopted for making this comparison of length will be described farther on.

The second difficulty, that of keeping the apparatus at a given length in spite of the changes of position, temperature, and moisture, or of making a perfect correction for these changes, has always been a great one. Various means have been tried. Steel chains very carefully made, are found to be very unsatisfactory in practice, owing to the difficulty of keeping them uniformly stretched, of supporting them throughout their entire length, and of determining and applying the correction for temperature. Glass rods have been tried, giving no better results. Deal or other wooden rods are rather less accurate than either, as they are very readily affected by the varying moisture, and will warp and twist in all directions.

As an illustration of these changes, I give the following comparison of the different lengths of the same base measured on Hounslow Heath, English Ordnance Survey:

With deal rods	27405·7607	feet.
With glass rods	27403·38	feet.
With steel chain	27402·38	feet.

The difference between the measurement with deal rods and the steel chain being 3·3807 feet in a base of about five miles.

To obviate this difficulty, arising from change of length with the temperature, the principle of compensation already used in the pendulum, was introduced by Captain Colby, in the apparatus for the measurement of the Lough Foyle base in 1827. Two bars, one of iron and one of brass, fastened together in the middle and free to move at the ends, carry at each end a "lever of compensation," so proportioned to the expansion of the two metals, that while they move relatively to each other, a fine platinum point on the lever maintains an invariable distance from the centre of the apparatus, and consequently, from the point on the lever at the other end. That is, the distance between the two platinum points is invariable and independent of the change of temperature. Using two sets of these bars in the measurement, the points on each are brought within the proper distance of each other by means of two microscopes mounted on a compensating bar of a few inches in length.

This apparatus gave moderately good results, but was not very convenient in use, owing to the difficulty of setting the microscopes in making the coincidence with sufficient rapidity.

A compensating apparatus on the same general principle was constructed by Simeon Borden, Esq., C.E., of Massachusetts, and used by him in the survey of that state in 1830.

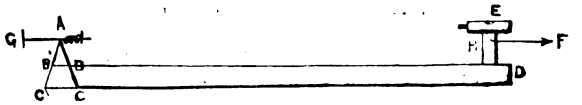
The "rules" of Borda made for the survey of France, were constructed on rather a different principle. The rule or bar itself was of platinum, the expansion of which metal by heat had been determined with much care, and close alongside of it, and attached firmly at one end, was a bar of copper, the coincident edges of the bars at the free end being divided in arbitrary divisions read by a vernier on one bar; this constituted in fact a metallic thermometer, and the changes of temperature of the platinum were read on the scale, and the proper correction for temperature thus determined.

In none of these arrangements had any attention been paid to the different specific heats of the composing metals. In Captain Colby's apparatus, the absorbing qualities of the rods were partially equalised by the coatings of varnish upon their surfaces, but their cross sections were exactly the same.

In the years 1845-46, Professor Bache having taken charge of the operations of the survey of the coast of the United States as superintendent, determined by a long series of very careful experiments, the relative cross sections of the bars of iron and brass, which were to constitute a new base apparatus for the use of the survey, depending upon their differences of specific heat and conducting power, the absorbent qualities of their surfaces being adjusted by the use of different coloured varnishes.

The apparatus as it now exists was arranged by the superintendent, and made in the Coast Survey office, under the direction of Mr. William Würdemann at that time mechanician of the survey. It consists primarily of two bars, one of iron, the other of brass, about 19 feet long, firmly fastened together by means of a piece at one end, and perfectly free to move past each other longitudinally in expanding or contracting, being hung on rollers in stirrups from the iron truss frame which stiffens the whole apparatus. The skeleton diagram here given will serve to show the relations of the several parts.

In this diagram the relative proportions of the parts are not preserved, it being much distorted in order to show the arrangement more clearly.



D B is the iron bar, D C the brass bar, firmly united at D; at C, the lever of compensation A C, is jointed to the brass bar, and its polished steel surface at B, is kept pressed against the end of the iron bar D B, by the spring represented near A, which is so attached to the small rod A G, which has a slot in the middle wherein the end A of the lever works, that it constantly acts to draw the rod back, and the end of the lever along with it. The arms of the lever A B and A C are proportioned to each other as the expansion of iron to brass. A B : A C : : 1100 : 1748, or very nearly as the expansions given by Smeaton of iron ·00125800, and by Laplace of brass ·00186671.

So by reference to the diagram it will be seen, that when the iron bar expands by heat from B to B', the brass bar will have expanded from C to C', and the arms of the lever being properly proportioned to these expansions, the point A of the lever will not be moved, but will keep exactly its normal distance from D. The expansion of the iron rod G, is allowed for in the arrangement, and it carries upon its end G, a polished agate plane rather less than a quarter of an inch in diameter, which is the surface of contact at that end of the apparatus.

We now come to the third difficulty mentioned, that of making the contact or coincidence of the ends of the bars so that it shall be accurate, safe, and convenient, for the method of operation must be by placing one in the line to be measured with one end directly over the starting point, and then bringing the second in the line, and accurately coinciding with the end of the first, either by actual contact, or by being kept at an invariable distance by means of reading microscopes.

Microscopes as used by Captain Colby and Mr. Hassler on the old coast survey apparatus, are inconvenient and difficult to adjust with speed and accuracy, and in devising the present apparatus, Prof. Bache applied the contact level of Bessel, which had been hitherto used for the purpose of observing comparisons of length. The action of this level is shown in the diagram.

F H is a small iron rod similar to A G, but carrying an agate knife edge, with its edge horizontal, instead of a plane. E is a small delicate level moving on a centre, represented by the small black dot between E and H, and supported from the bars. From

* From the 'Journal of the Franklin Institute.'—The information is taken from the Archives of the Coast Survey, communicated by authority from the Treasury.

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the lower side of the level a short arm projects, against which the end of the rod F H abuts; the inside end of the level is weighted, so that it naturally assumes an inclined position and pushes the rod F H out, any undue motion being prevented by stops. The distance between the two agates is therefore always a little more than the standard length, six metres, and it is so adjusted that when the rod is pushed in, moving the level in the manner of a bell crank, the bubble stands in the middle when the agates are just the proper distance apart; in short, the position of the bubble in the centre of its run indicates the accurate adjustment of the length. In reality the contact level is not fastened directly to the bars themselves, but to the bar of a very delicate sector level, the centre of motion of which is exactly in the axis of the agates, and which is kept always level, so that the inclination of the bars, which is sometimes unavoidable on uneven ground, does not affect the position of the contact level. This sector level serves also to show the inclination of the bars from the horizontal plane, in order to apply the correction for versed sine.

These constitute the essential parts of the apparatus. The bars are suspended in stirrups from a plate iron truss frame, which keeps them steady, and the whole is enclosed in a double tin tube with an air space between the two parts to prevent sudden changes of temperature being communicated to the bars, with glass doors in the middle and at the two ends, for the purpose of reading the enclosed thermometers and observing the contact. From the fact of these tubes being the visible part of the apparatus, each piece of apparatus is technically called in Coast Survey parlance "a tube," a base being said, for instance, to consist of so many tubes, meaning so many times six metres.

To each *tube* at a distance of about 5 feet from each end, is lashed underneath it and transversely, a bar or *handspike*, by which the tube is carried, four men acting as *bearers*. Close to this handspike, and at the rear end of the tube, are a pair of trunnions running transversely, which fit into corresponding horns on the rear trestles, and at the forward end a plate with two holes which fit on two projecting pins on the top of the fore trestles. The trestles are tripods of iron, the legs resting on foot screws, and capable of elongation by a telescope arrangement worked by a rack and pinion, and a vertical main screw which raises the head, which has the two motions of a slide rest in the horizontal plane, the transverse motions of both trestles, and the line motion of the rear trestle being governed by screws, precisely like those of a slide rest, and terminating in square shanks to which the handles may be fastened. Each trestle carries a small circular level for adjustment. Eight trestles are required. Ten cast-iron plates made to receive the foot screws of the trestles, a wooden frame for placing the foot plates in the proper position, and a wooden bar with a sector level upon it for setting the trestles at the proper distance and level to receive the tubes, complete the equipment.

Upon first arriving on the ground, the comparisons of the tubes with the standard iron six metre bar, are made for the purpose of insuring that no change has taken place during their transportation.

For this purpose two stone or hard wood pillars are sunk in the ground, at a distance of six metres apart and properly protected from the effects of surrounding vibrations by wooden boxes around them in the ground.

Fixing the points of the compass for convenience, at a distance of 20 feet north from the east pillar, another pillar is sunk, the tops of all being on the same level, and about the height of a trestle from the ground. Two trestles on their foot plates are placed in the proper positions in the line between the pillars, and the tube placed upon them. On the top of the west pillar is a brass plate with a vertical part, through which passes the *abutting screw*, a steel screw with a square end made perfectly perpendicular to the axis of the screw, and adjusted so as to be in a vertical plane.

The agate knife edge abuts against this screw. On the top of the other pillar is fixed a plate carrying a vertical standard supporting a small mirror, which turns upon a vertical axis through a small arc, an arm projecting from the back of the mirror carrying a fine screw with a rounded end, which rests against the agate plane of the east end of the tube, a spring keeping it always against the plane.

On the third, or north pillar, which is at right angles to the line of the tube, and opposite the east pillar, is a small theodolite telescope with a vertical hair, so placed that a graduated paper scale placed directly underneath it, can be seen through the telescope reflected in the mirror. All being arranged, the standard iron bar supported in its box is put in the *comparator*, levelled by the trestle screws, and the end made to abut against the screw on the west pillar; the *mirror screw* resting against the agate plane, a certain part of the scale is reflected in the mirror, and read through the telescope, by its coincidence with the vertical hair; this reading is noted, as is also the temperature of the bar at the ends and the middle as indicated by the attached thermometers; the bar is then taken out and one of the tubes substituted; this is moved in a longitudinal direction, until the contact level is brought exactly right by the pressure of the knife edge against the agate plane, and the reading of the scale as reflected into the telescope again taken; the difference of reading gives the difference of length between the *tube* and the *standard*. The bar is then again put in, and this is repeated a great many times with each tube, the exact length of which compared with the standard reduced to a constant temperature being thus determined. There are sixty of these scale divisions to 11·68 inches on the scale, so that the actual length of each division is very nearly one-fifth of an inch, and therefore very easily read. Owing to the difference of length between the arm on the back of the mirror, and the distance between the mirror and the scale, one scale division corresponds to a change of length in the bar or tube of ·000157 of an inch, giving the means of ascertaining with great delicacy the minute changes in length in the bar.

This arrangement of mirror and scale, is known as Saxon's pyrometer, and has been before used in magnetic observations.

The comparisons are usually continued for two or three days, and the results afterwards reduced in the office. These being finished, the actual measurement is begun, the end of the base has already been marked in some permanent manner, and the line has been carefully ranged out as in running a tangent on railroad work.

A good transit is set up on a continuation of the line run 40 or 50 feet back, and adjusted to bear upon the signal at the other end of the base or upon the proper range marks. Stubs have already been driven at distances of about 200 metres along the line and the centres accurately marked.

The tubes are ranged in line with the transit, by means of two sight vanes which they carry at their forward ends, the plates are laid in the places where the advancing tubes are to come, and the four trestles not in use are placed upon them. A transit instrument is then set up in a line at right angles to the base at its beginning, and about 40 feet from it, and the agate knife edge brought carefully over the point in the copper bolt beneath it. The agate plane on the forward end of the first tube is exactly six metres from the copper bolt, the second tube is then drawn back by means of the distance screw of the trestle, until the contact level reads level; when the agate plane of its forward end is exactly twelve metres from the bolt, the number of tubes, the temperature, and the inclination, or the note, level, if there is none, is recorded.

The superintendent makes the contacts during the whole of the operation. So much being ready, the superintendent when the contact is perfect says "made," "break," whereupon the assistant at the rear end of the first tube draws it rapidly back by means of the distance screw.

The trestle screws have long handles with a universal joint which can be stuck on to any screw at pleasure.

The woodcut shows the measurement at the moment of making contact; the figure at the extreme right is the assistant, holding the distance screw just ready to turn off at the word "break." The handle of the main screw for adjusting the level is attached to the trestle and rests on the ground at his feet.

The superintendent, in a stooping position, is observing the contact level through the small window in the rear end of the second tube, and moving the tube slowly in the line by a fine motion screw with his left hand to make the contact. The first assistant is seen moving from his place at the forward end of the second tube to the forward end of the first tube, to take charge of its advance, upon hearing the order "break," while the assistant is turning off, the four bearers, only two of which are represented in the drawing, advance to their places on each side of the tube. The first assistant having arrived at his place, turns the tube out of the line by means of the azimuth screw in the front trestle until the superintendent says "clear;" the order is then given to the bearers "raise forward," "step out," "raise aft," "step out," "forward," and the bearers supporting the tube by the hand-

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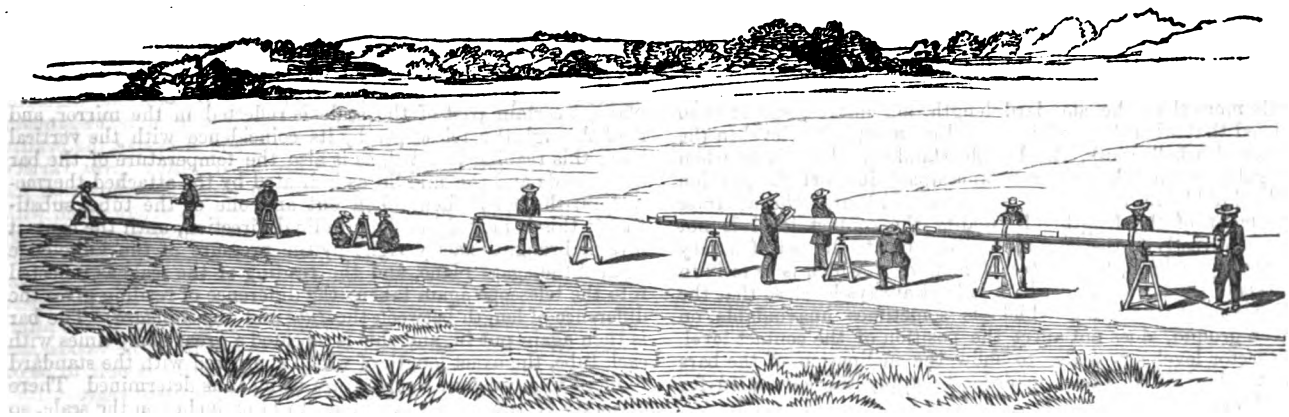

spikes carry it past the other tube to its place in front; the assistant at the rear hastily detaching his two handles and following the tube, holding on to it to guard against accidents from a bearer stumbling.

"Halt" is then called; the trunnions of the tube are placed in the horns of the rear trestle, and the tube is slowly swung into its place, the superintendent watching the agates closely to see that all is clear; when all is right the bearers step aside, the tube is aligned by the observer at the transit; the level adjustments are made by the assistants with their trestle screws; the contact is made roughly by the rear assistant with his distance screw, and he goes back to his old place as represented in the sketch, ready to turn off again at the word "break."

In the meantime as soon as two trestles are disengaged by the advance of the tube, four trestle men immediately carry them forward, and place them upon the plates already set for them, as is shown in the drawing, and two plate bearers stepping inside of the plates, which are hollow, lay them in their proper places in the wooden frame which guides them, a man preparing the beds for them with a hoe. An officer with the bar carrying the sector level, sets the trestles at the proper distance and level for the reception of the tubes, and arranges the adjustment of the trestles to suit the varying nature of the ground. When the tubes cannot be exactly level, the inclination is read and noted, and the correction or the sum of the corrections, which is the sum of the versed sines of the angles of inclination to a radius of six metres, is subtracted from the measured length. The temperature, number of tubes, inclinations, &c., are recorded by an assistant who is shown on this side of the tube.

On leaving the tubes for breakfast and dinner, a stub was driven under each end of the last tube, and a lady's ordinary dressing pin driven into it, exactly under the agate as aligned by a transit instrument, placed at right angles to the line.

At night more permanent marks were made by driving three stubs, one under the end of each tube and one under their intersection, and marking the points projected by the transit upon copper nails driven in them.

The tubes are allowed to remain in their places all night, covered by their india-rubber cloths, a guard being left with them in any country where there is danger of their being disturbed.

On commencing operations the next morning, the points are verified by the transit instruments, and the measurement continued as before.

At every distance of 268 tubes, or about a mile, granite mile stones are sunk with the point carefully projected upon a copper bolt, and further fixed by two stubs in the line and two at right angles to it, the intersection of the lines passing through them marking the point.

At the end of the base, if that end has been already marked and connected with the triangulation, the distance between the point and the end of the last tube is carefully measured with a fine beam compass.

The apparatus is then carried to the comparing tent, and two or three days spent in careful comparisons with the standard, while the other assistants make the marks permanent and set the monuments, marking the ends of the base.

On referring to the map of Florida, it will be seen that the great chain of Florida Keys commences at Key Biscayne (Fort Dallas), near the south end of Florida, in latitude 25° 39′, longitude 77° 03′, and sweeps off in quite a regular curve of nearly a quarter of a circle to Key West, in latitude 24° 32′, longitude 81° 47′, extending, in fact, in a few scattered keys to the Dry Tortugas. The main land runs in a southerly direction, to a point opposite Carysfort Reef, then turns suddenly to the west as far as Cape Sable, which is the extreme southernmost point of the main, leaving Florida Bay and Barne's Sound, quite considerable sheets of water, between the reef and the main.

Outside of the range of keys, and about ten miles from them, runs the Florida Reef, which is of coral rock, and extends almost to the surface, the dread of all coasting vessels, which, in order to get into the Bay of Mexico, must enter the narrow passage between Cuba and the reef.

The dangers of this coast have always been considered very great, and the number of shipwrecks is proved by the extensive wrecking business that has always been carried on at Key West.

The determination of the positions of these reefs and keys is, of course, an object of great importance, and is attended with considerable difficulty on account of the entirely uninhabited condition of the keys, the flatness of the country, and the immense amount of detail requisite for the proper delineation of the keys. For the purposes of the triangulation sites for two bases were selected, one on Key Biscayne and one on Cape Sable, and that on Key Biscayne measured with iron wires, connected with the triangulation which was based upon it, and the south end occupied as an astronomical station.

Preparations were made for the final measurement of these two bases with the base apparatus in the spring of 1855, and accordingly, the superintendent who always conducts the base measurements himself, with his party arrived at Key Biscayne on the 2nd of April, and immediately commenced operations.

The camp had already been pitched on the sea shore near the south end of the base, which ran nearly north and south. The island is entirely uninhabited, except by the light-house keeper and his family, and covered on the north-west side with dense forests of black and red mangrove, and on the south-east with a thick growth of the scrub fan palmetto, with here and there a sea grape tree and a few bushes. A fine sandy beach, not of great width, extends along the eastern side, on which the base on which the secondary triangulation of the keys rests, had previously been measured with iron wires.

The line had been grubbed and graded throughout nearly its whole length of three and a half miles, and both ends marked in the usual manner by copper bolts let into heavy stone monuments sunk to the level of the ground and capped with a small stone pyramid, so that they could be again found.

South Base had been previously occupied as an astronomical station, and its latitude, longitude, and azimuth determined. The line was also chained and levelled for the profile. It was arranged that the measurement should be commenced at North Base, so that we should work towards camp, and after the comparisons were finished, the tubes, trestles, &c., were taken there in a flat towed by the schooner.

The actual measurement was now begun. At four o'clock in the morning, the summons to turn out was given, and by half past four all the party were on the way to North Base, a distance of about four miles from camp. Arrived there, the tubes which had been placed in the line the day before, were uncovered, and

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the transit set up in the continuation of the line, as mentioned, the position of the first tube over the initial point adjusted by the transit across the line, the levels of the sectors tested with an engineer's level, and the measurement commenced as before generally described. The work was continued until eight o'clock; from eight to nine was devoted to breakfast on the line; the work then resumed until one; dinner on the line from one until half past two, and operations resumed until about five, making about eight hours a day of actual work. The work of the first day or two lay through black mangrove woods and swampy ground, and the musquitoes and sand flies tried the patience of the observers sorely; the trees, too, cut off the sea breeze, and, although in the shade, the thermometer stood at an average of 84°·5 F. At night the tubes were covered up, the trestles dressed in their triangular canvas covers, and left without any guard, as there were no inhabitants to disturb them and no signs of any Indians.

After leaving the woods and coming out upon the open plain, which was covered with scrub palmetto about 4 feet in height, through which the path was cut, the heat was, at times, very oppressive even when tempered by the sea breeze. Nine days were employed in the measurement, half a day being lost on account of rain, and half a day from an accident to the apparatus, which, however, was repaired without much delay. The end of tube 965, reached beyond the marked point of South Base, and being projected on a stub in the ground, the distance 0·34775 metre was measured back with a beam compass.

The last tube was set in the afternoon just in time to finish and get the tubes into camp before dark.

In camp the comparisons were resumed and resulted very satisfactorily, the sandy ground being extremely firm and the posts consequently stable. An improvement was made in the scale by lengthening it so as to bring on the whole range of the changes instead of part of the range, being read from the terms of the mirror screw, as was the case before.

The whole apparatus was then packed up and despatched in the schooner *Bowditch* to Cape Sable by the Duck Key passage.

The superintendent proceeded to Cape Sable by way of Key West, coasting along the reef and inspecting the triangulation and topography. At Saddle Hills, near Key West, word was brought him from Cape Sable that the condition of the prairie at that place would make the measurement impossible, for the ground, which is but little above the level of the sea, was only a pasty mass of mud, owing to the heavy rains. Such information was very discouraging, but preparations were made for immediate departure for the scene of difficulty, and after a delay of a short time at Key West, owing to a continuous north-east gale, the schooner swung at anchor a few hundred feet from Fort Poinsett, a mythical kind of establishment on the point of Cape Sable, consisting of an embankment forming two sides of a triangle and capable of holding about a hundred men.

Here things were found to be in rather better condition than was anticipated, the rain had ceased, and the ground had attained a sufficient solidity, for the purposes of the measurement.

The absence of the camp, which was to have been pitched, was satisfactorily accounted for by the tales of the musquitoes, which were described as exceeding anything of the kind in any other part of the world.

A party, consisting of an officer and several men, which had been left on shore with a camp for two days and nights, were taken off in a state of absolute exhaustion from want of rest, having spent all night in combat with these fearful insects.

The whole party had therefore to content themselves with their rather restricted quarters on the schooners, which were anchored about a mile out in the bay to avoid these flying marauders, which would have troubled us at a shorter distance from land.

As it was uncertain how long the fine weather would last, it was determined to commence immediately with the measurement and to postpone the comparisons until the end, and very fortunately, as the event showed, as, when the levels were run over the line after the measurement, the ground had already become somewhat soft from rain, and the last day on shore was memorable for a drenching rain, which fell much to the annoyance of the parties who were finishing the operation.

Cape Sable Prairie, as far as it has been explored, is a strip of five or six miles in width, between the sea and the everglades, bounded on the west by the sea, and extending an indefinite distance towards the east, a doubtful sheet of water called White Water Bay, the position of which is rather a matter of uncertainty, being to the north of part of it, and the everglades completing the northern boundary. It is an exceedingly beautiful place, apparently made for the site of a base line, as smooth and level as a floor, and carpeted with a great variety of plants and grasses, some of which change their colours with the different stages of growth and give beautifully varied hues to the ground.

Mangrove hammocks of varied shapes and sizes spot the prairie at intervals, and these hammocks are filled with a great variety of orchids or air plants which grow in great abundance on the trees, the cactus, whose short stinging pines interfere much with the passage through them, and the Spanish bayonet, whose magnificent white spike of flowers frequently shows out against the dark mangrove. But this beautiful place is cursed with musquitoes, so that we found it impossible to begin work on shore until nine o'clock, a.m., and necessary to stop by five in the afternoon; after this time clouds of them issued from the woods, and assailing any individual who was unfortunate enough to be on shore, drove him to the boats in a state of impotent rage.

The measurement here was briskly carried on, the level nature of the ground making the operation very rapid, the average time of one tube being 2′ 51″ against 4′ 20″ at Key Biscayne, and many of the tubes were made in less than 2′. An average of 2′ 51″ would make about one-tenth of a mile an hour, but in some of the hours as much as one-eighth of a mile was done, showing a rapidity of measurement hitherto unapproached in any of the base measurements with other forms of delicate apparatus. Eight days were occupied in the measurement of this base, which is 1072 tubes or 6432 metres in length, a trifle short of four miles. The ends of the base and the first and third miles were marked by iron screw piles sunk level with the ground, and filled with concrete, a copper bolt being fixed in the centre on which the point was marked, two smaller piles in the line and two across it, marked still further by the intersection of the lines through their centres the ends of the base. The second mile being the centre of the line and on firm ground was marked by a granite monument.

The annexed table gives the comparison of the measurements of the bases at Dauphine island, Bodie's island, and Edisto, with the Florida bases.

Neither of the bases were measured more than once, partial re-measurement on other lines having shown the probable error to be so exceedingly small as not to be important, it being noted as about $\frac{1}{10}$-inch for the entire base.

Six officers, including the superintendent, and about sixteen men are required for the operations in the field, besides those in the camp or on the vessels, cooks, &c. In the sketch a number are omitted to prevent confusion, and the officer at the transit aligning the tubes is too far along the line to be visible.

The Cape Sable Prairie is well stocked with deer, numbers of which were seen every day, and a sufficient number shot to keep the party in venison for some time.

The Indians, if there were any in the neighbourhood, kept carefully away, perhaps deeming the party too strong for them, although they must have been attracted by the clouds of smoke which rolled up from the prairie which we had set on fire for the purpose of clearing it.

The long walls of flame as seen at night from the vessels, added very much to the beauty of the scene.

One large black bear, which fell a victim to the men who pursued it into the water and despatched it with boat-hooks and oars, a few coons, some wild cats, and forty-three alligators, which a reconnoitering party saw holding a caucus in a creek, were all the wild animals that we met with.

On the 17th and 18th of May, all the operations being finished, the party left Cape Sable on their way to the north, everything having been accomplished without any accidents or serious sickness, although all the men were from the north and unused to out-door work in such a warm climate.

The triangulation based upon the original Key Biscayne base, measured with wires, has been carried on down the reef, and that base having been connected with the new one, the small correction necessary for the sides of the triangles can be applied, it being too small to affect the topographical work.

It may not be amiss in concluding this article to give the references to articles on the measurement of bases and the different forms of apparatus that have been devised for that purpose.

L. B. Francœur, Traité de Géodésie, p. 129, and Notes sur le Mesure des Bases, in the same volume. Frome, Outline of

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	Dauphine Island.	Bodle's Island.	Edisto Island.	Key Biscayne.	Cape Sable.
Whole number of tubes measured	1777	1807	1787	965	1702
" " " days employed	17	10	13	9	8
" " " hours	143 h. 17 m.	81 h. 08 m.	97 h. 28 m.	66 h. 31 m.	46 h. 26 m.
" " " tubes level	961	1496	862	473	994
" " " " inclined	816	311	925	492	78
Average length of working day	8 h. 25 m. 7 s.	8 h. 07 m.	7 h. 30 m.	7 h. 23 m.	5 h. 48 m.
" " " time of one tube	5 m. 32 s.	2 m. 54 s.	3 m. 22 s.	4 m. 20 s.	2 m. 51 s.
" number of tubes per day	104·5	180·7	137·5	107·2	134
" " " " " " of 9 hours...	108·0	197·9	165·9	130·0	200
Average number of tubes per hour	11·85	21·98	18·4	14·4	22·47
Temperature of attached thermometer	84°·5 Fahr.	52°·0	59°·5	82°·9	87°·9
Average tubes per hour of greatest day's work	18·4	30·7	22·3	17·7	29·9
Greatest day's work, miles	0·70 mile.	1·06 mile.	0·75 mile.	0·63 mile.	0·73 mile.
Date	May, 1847.	Nov., 1848.	Jany., 1850.	April, 1855.	May, 1855.

Trigonometrical Survey, p. 5. Aide Memoire to the Military Sciences, London, *Art.* Surveying. Lieut. Hunt's Description of Apparatus and Plate of Details, U.S. Coast Survey, Report for 1854, p. 103. Hackley's Trigonometry, p. 316. Everest on Arc of Meridian in India, 4to., p. 50. Captain Yolland, Lough Foyle Base. Palfrey's Tables, Survey of Massachusetts. Trans. Am. Phil. Soc., Vol. ix, p. 34. N. Am. Rev., Oct. 1845, p. 458. Coast Survey Reports, 1847, p. 39; 1848, p. 43; 1849, p. 38; 1850, p. 34. Recueil des Observations Géodesiques, par Biot et Arago. Base du Systeme Métrique Decimal. Puissant, Geodosie, p. 203. Davies' and Peck's Dictionary of Mathematics, pp. 61, 272.

ARCHITECTURAL IMPROVEMENTS OF LONDON.

No. I.

In calling the attention of our readers to the architectural improvements recently completed, and now in progress, in the metropolis, it may not be deemed amiss to take a brief retrospect of what has been effected during the last few years. In doing this, in point of quantity, we must necessarily commence with the buildings designed and carried into execution under the superintendence of the late Mr. Nash, who was so liberally patronised by George IV.

Amongst the more important works by Nash, may be enumerated Buckingham Palace, Regent-street, the Quadrant, Waterloo-place, and some of the Terraces in the Regent's-park. In reference to the capabilities of Nash to design a palace, there can but be *one* opinion—viz. that he was totally unfit for such an undertaking, which was clearly demonstrated in the feeble and contemptible affair that he was unfortunately allowed to produce, it being entirely destitute of all those more prominent features which ought to distinguish, in an eminent degree, a structure of such great national importance. In considering Nash's powers, in the designing of street architecture, Regent-street, setting aside the materials which he employed—namely, brick, compo, and mastic—a more favourable enunciation of his peculiar faculties for design was developed, as a whole; but his combinations will not stand the test of critical examination when taken in their details, some of which are puerile and eccentric in the extreme. Some of the Regent's-park terraces, attributed to Nash, although they assume attempts at grandeur of conception, are wanting in boldness, light and shade, and that vigorous treatment which distinguishes the work of an artist of original and comprehensive genius.

The works of the Adams' in the Adelphi, and other parts of London, may also be alluded to as samples of street architecture, but they are of the same feeble school with those of Nash, and merely differ in the material shown externally; for, whilst Nash covered the face of his brickwork with artificial compositions, and scored it in lines to imitate stone, the Adams' left the stone and brick to tell its own genuine tale.

Next to the Adams', we may briefly advert to the productions of Sir John Soane, who displayed a considerable amount of genius in composition, and also great ingenuity in the internal arrangement of some important structures which he erected; the principal of which is the Bank of England,—somewhat defective, however, in the altitude of its basement story, which thereby detracts from the dignity and importance of the edifice.

Another eminent architect who was entrusted with designing some important buildings in London, was Wilkins, who, however, was so fettered by government, in one of his most conspicuous works—the National Gallery—that he cannot be said to have had a fair chance for the exercise of his peculiar genius. But this has most unfortunately been the case, in England, since the days of Wren, down to our own time,—the system pursued, being, to commence with a curtailed sum, by which the architect's hands are tied, which generally ends in double or triple the original sum being expended, and in the building being eventually entirely spoiled: whereas, if the judicious architect had, in the first instance, a liberal sum voted for his use, equivalent to the production of a really great work, he would in this case proceed with confidence, and in the hope of certain success, without having to cut down this and alter that, until his original conception is completely marred, and he turns from his work with a feeling near akin to disgust, instead of following it up with ardour and enthusiasm to a glorious conclusion.

As we are now only commenting upon what has been executed in London during the last thirty years, we shall not have the disagreeable task of describing some of the anomalies which have been perpetrated at some of the royal residences in the country, and the mansions of the nobility: but at the same time it is most truly lamentable to reflect seriously on the enormous sums of the public treasure that have been so shamefully wasted upon structures, which instead of being an honour to the nation, are only objects of facetious comment to our foreign neighbours. Thus, we find that, unlike France, we do not erect our national edifices for an admiring posterity, for whilst ours are hacked about, and in many instances entirely demolished in a few years, the Louvre and the Tuileries remain unaltered, as the most striking national monuments in Europe.

Let us earnestly hope, however, that a new and brighter era has began to dawn upon us, and that, ere long, public buildings and street architecture may be produced in our metropolis which may fairly vie with the productions of continental nations.

In judging of what has been produced in London within the last few years, and by an examination of the designs which were exhibited at the recent architectural exhibition in Suffolk-street, it is evident that the Italian elements of architectural composition are destined to be very largely employed in forthcoming works, notwithstanding the false prophecy of Leo Von Klenze,—the erratic and dogmatic denunciations of Pugin,—and the seductive sophistries and fallacies of Ruskin. It is, therefore, somewhat cheering to observe a forcible and energetic indication, of men, endeavouring to produce something much more satisfactory in the various club-houses in and near Pall-Mall, the street buildings of Cannon-street and other parts of the metropolis; and if they do, as yet, in most instances, merely elucidate a sort of successful copyism, there is ardent hope that more successful productions will eventually be enunciated, so that something of a true architectural character may be redeemed in England, and recal to our memories the genius of Inigo Jones and Sir Christopher Wren.

One of the best signs of the present time is, that we have at length began to reject the brick and compo architecture of Nash and his unworthy followers, and to show material in its *propria persona*, if we may be allowed the expression. This has in some measure began to be carried out on the southern side of Cannon-street, and although some of the designs are sadly too trifling in

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their character, and do not harmonise very well together, yet they are a step in the right direction. Another very praiseworthy instance we may mention, is a very important block of buildings now just completed, situate at the corner of Chancery-lane and Fleet-street. In designing this building, the architect, Mr. Knowles, has evidently departed from the regular system of Palladian arrangement, more particularly in the important features of the windows, which, instead of being square and pediment-headed, are all semicircular, and their jambs splayed; their arched heads are also finished with a sort of label moulding, resting on small corbels, which is somewhat objectionable, as giving the windows something of a Gothic character. The upper cornice of the façade is of Italian character throughout, and though it has many features of elegance is rather too heavy in its proportions. The basement-story of this edifice is perhaps the most successful portion of the composition, being conceived in a bold and vigorous, although simple and effective manner, and having considerable altitude, gives to the whole building a dignity and character most effective. It consists of a series of semicircular-headed arches of noble proportions, somewhat similar to those of the Strand-front of Somerset-house, and decorated with carved heads on the key-stones of the arches. These heads reflect a very considerable amount of credit upon the artist who executed them, and if they do not possess so much nicety of handling as those at Somerset-house, they are in some respects superior, as having more nature infused into them, particularly as regards the arrangement and treatment of the hair; for, whilst Bacon's productions appear to have been executed from models adjusted and curled for the occasion by an eminent perruquier, those on the arches in question have the appearance of being produced from a careful study of nature, without the aid of artifice. The materials employed in this structure are white bricks for the plain surfaces, and all the projections and carvings are Portland stone. The contractor was Mr. Myers, who has carried out the various works in the most admirable manner, both as regards material and sound workmanship. It is suggested that if the quoin-stones were rusticised or vermiculated, the general effect of the façades would be much improved.

Several new and admirable features may also be recognised in the tavern, designed by Mr. George Legg, recently finished, immediately opposite to the Chancery-lane front of the building to which we have just adverted, that are well worthy the careful attention of the architectural student.

Whilst we are in this neighbourhood we may also direct the reader's attention to another very successful specimen of Italian architecture, comprehended in the narrow front of the building used as the offices of the London and Provincial Law Assurance Society, in Fleet-street, and nearly opposite to the edifice we have been describing. The frontage of this building, although only 18 feet in width, is well deserving of an examination. The general feeling of the design is in the true Palladian character, composed of the regular Tuscan, Doric, Ionic, and Corinthian orders, in their usual vertical arrangement; the basement, of course, being Tuscan. The whole composition may be justly pronounced as a model, both of design and careful execution. The material employed is Swangate stone, from the island of Purbeck; the architect, Mr. Shaw, of Christ's Hospital; and the contractors for the work were Messrs. Lock and Nesham, at an estimate of 4988*l.*, upon whom the sound and careful execution of the work reflects the highest credit.

We have been enabled to advert to the foregoing examples of our London improvements with some degree of satisfaction, but are compelled to the unpleasant task of referring to some that, instead of being improvements, are real blemishes and failures. As in literature there is but one step between the sublime and the ridiculous, so in architecture there is but one step from the beautiful to the positively ugly. One of the unsuccessful specimens we wish to guard the inexperienced student against, is the elevation of a house in Great Russell-street, which has recently been coated over with Portland cement, an attempt having been made to embellish it in the fantastic style of Louis Quatorze, but in such an unartistic style that the façade presents a *tout ensemble* of the very worst description that could well be conceived. In the same bad taste, the shop-front and elevation of the house on the southern side of Fleet-street, forms another lamentable illustration of the folly of attempting to carry out works without consulting competent persons in their execution; for, assuredly this is one of the most clumsy and inconsistent productions that was ever perpetrated, whether considered in a constructive or a decorative point of view. The whole superstructure of this building appears to rest on enormous sheets of plate-glass (like a similar abomination on Ludgate-hill); and as for the composition ornaments above the glass, why they fairly baffle description, being of that *outre*, confused, and heavy description, that they may be said to outrage all the known rules of architectural or decorative design. Another example of this apparent resting a house upon glass may be observed in St. Paul's Church-yard, in which this transparent material is carried up to the joisting above the first floor, which looks sufficiently preposterous; but, as if to arrive at the *ne-plus-ultra* of absurdity, the front of the house is made to appear as if it were supported by glass columns of the most slender proportions.

In contradistinction to this most inconsistent mode of construction and general treatment, we have pleasure in calling attention to the shop in the Fleet-street front of the block of buildings to which we have had occasion previously to allude, in which the window is divided into three lights by iron columns, terminated with appropriate capitals, which support the brestsummer, and consequently give the appearance of proper strength and constructive utility.

Our space will not allow us at present to extend our notices, but as there are many other buildings in London worthy of examination, either recently erected or now in progress, we shall resume the subject next month.

ON DIRECT-ACTING STEAM-ENGINES FOR HEAVY PUMPING.

By David Landale, Mining Engineer.

[*Abstract of a Paper read at the Royal Scottish Society of Arts.*]

This paper was illustrated with numerous drawings, showing the progressive improvements on the three-valved or single-acting engine, as left us by Watt, up to the present day. The Cornish engine was described, and the interior arrangement of pumps, as wrought by it in a deep shaft, illustrated by a section. Of the new direct-acting engines, six were mentioned as erected and working since 1852, and other three large ones, for 110 and 160 fathom pits, were now being made by Neilson and Co., Glasgow, while the engineers in Lancashire had made about as many in the same period, but of the non-condensing kind, and the direct-acting engines were slowly making their way against strong prejudice, because of their cheap first cost, which is only one-half of that of a beam-engine of the same power. There were two kinds of the new engine described, both condensing high pressure, and expansive; one with a 40-inch cylinder and 12-feet stroke, which was simply a Cornish engine turned upside down, the cylinder resting on a strong sole-plate over the mouth of the shaft, and the piston-rod attached direct to the forcing set-pump rods. The air-pump was small in diameter, with the same length of stroke as the engine, thus doing away with the ponderous beam, parallel motion, and heavy masonry of the cylinder pedestal, lever wall, and engine-house, and obtaining any desirable length of stroke by merely adding to the length of the cylinder and piston-rod, thereby increasing the efficiency of the pumps and making smaller ones do the same work. The second kind of engine was also inverted over the shaft, and secured and attached to its work in precisely the same way. It also uses high-pressure steam expansively; but its peculiarity consists in there being a constant vacuum above the piston, both during the descent and ascent of the load. During a portion of the descent the piston is nearly *in equilibrio*, having a vacuum on both sides; that under being a partial, and the one above being about 12½ lb. per square inch, or the common condenser vacuum. As the piston and load continue to descend against this vacuum, a self-acting valve shuts towards the piston, and a full vacuum (showing 15 lb. per square inch on the gauge) is acquired by the time the piston has got to the lower end of the cylinder, thus giving a tension or extra pressure, equal to 4 tons on the 70-inch cylinder, at the moment where it is most required to overcome the *vis inertia*. The steam-valve is then opened, and high steam admitted for the up-stroke. There are only two double-beat valves worked by the engine. The vacuum valve is self-acting, oblong, and hinged, working on the upper port of the cylinder; and the machine does its work admirably.

It was explained that many attempts had been made to use direct-acting pumping engines from an early date without success.

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The ingenious Symington erected a large one at Dysart colliery as early as 1810 or 1812. It worked with low steam and no expansion, and raised its water by two columns of 17-inch common lifting pumps, until 1849, when higher steam was used expansively, and a forcing set applied for the upper column of pumps, the lower one being still a lifting pump. The vacuum-valve was also introduced above, and the result is that the same old engine, made by Symington, now works pumps 23½ inches diameter, or almost twice the area, and doing twice the work with the same consumpt of fuel; and, from being the most troublesome *engine in the district*, she is now the safest and easiest kept in repair. The vacuum-valve is the invention of a working engineer named Mackenzie, since dead. Mr. Landale only claimed the merit of its after-introduction in these new engines, for which engines he claimed a saving of first cost equal to one-half—greater simplicity and less tear and wear, facility of getting a long stroke at an inconsiderable cost, and consequently smaller size of pumps.

Mr. NEILSON expressed himself strongly in favour of these engines, although there was less profit on their manufacture than the beam-engine. He enlarged upon the saving in the pit-work, and the advantage of the long stroke by fewer openings and shuttings of the clacks being required, and concluded by expressing his belief that a 20-feet stroke would yet be attained.

Mr. CADELL, while he gave Mr. Landale every credit for the ingenuity of this application of a pumping-engine, and admitted the great saving in the first cost, yet he could not agree with him as to all the advantages to be derived, while he saw several drawbacks which he would endeavour to point out. The first was, the placing of a cylinder of such a size over a pit-mouth was inconvenient, and prevented the proper application of the crab-rope to the pump-rods in cases of repair. The second was, that the piston and piston-rod were added to the weight of the pit-work, whereas in the old way, when hung on the opposite side of the beam, they acted as a balance to the pump-rods. A long stroke could be got in the old way by a longer beam, and the two-valved nozzles with the vacuum valve (of which he highly approved) could be applied to the beam-engine.

Mr. E. SANG, after asking some questions about the vacuum valve and the kind of foundation for the building on the pit-mouth, concluded by repelling some of Mr. Cadell's objections, and eulogising the direct-acting engines.

Mr. BLACK saw no difficulty in getting a foundation: it would be as easy for the direct-acting engines as the beam-engine.

Mr. ELLIOT also spoke in favour of the direct-engine, and particularly the perfect vacuum obtained above the piston at the proper time for the up-stroke; but he would advise Scotch engineers never to rest until they obtained the same *duty* as the Cornish engineers had done.

Mr. GOURLAY, one of the makers of these engines, concurred in every word that had fallen from Mr. Landale and others in favour of the direct-acting engines, and saw nothing in Mr. Cadell's objections. All he saw wrong with them was, there was too little work on them, too little iron and brass, and they were too easily made to afford so much profit to the maker.

Mr. LANDALE, in reply, said, with regard to the long-stroke, the old Dysart engine had a 6-feet stroke; he had begun with 9 feet, and in the last engine had arrived at 12 feet, and he might come to 15, but there were practical difficulties in the shaft, which, he feared, would preclude a 20-feet stroke. He was assured there was no real inconvenience found in practice by the half of the cylinder covering the end of the pit. There was a manhole in the cylinder bottom, through which all the upper dry rods were let down, and, after being once in their place, he did not expect their renewal during a whole lease; that with the lower pumps and rods several hundred feet down there was no real difficulty in the rope being 3 feet off the plumb for the short period it was required. As to the objection of the piston and rod being on the wrong end of the cylinder, he reminded them that with forcing pumps, in many cases, it was not so, but that weights had to be applied to the pump end of the beam; and as to getting as long a stroke with a beam, that involved a vast expense. The Balgonie engine, for instance, with an 8½-feet stroke in the shaft, had a beam 28 feet long and 14 tons weight; such a beam for a 12-feet stroke would need to be 38 feet long, and the additional weight and building to carry it were evils of no small magnitude, which it was the object of the direct-engine to avoid. He agreed that the two-valved nozzles and the vacuum valve could be applied to the beam-engine as well as the direct-acting one. As to the observation about the inferior *duty* done by Scotch engines, he begged to remark, that with the direct-engine, all the Cornish improvements in casings, clothings, and boiler could be applied to it exactly as to the Cornish engines, and he had not the least doubt, that as large a *duty* could be got here as in Cornwall (quality of coal considered). But, at most collieries, where the small coal is mixed with shale and dirt, the Cornish boiler is inapplicable, and, as that rubbish must be burned, and costs only from 1*s.* 6*d.* to 2*s.* 6*d.* per ton, parties will not go to the expense of steam-jackets and clothing of pipes and boilers, as they do in Cornwall, where coal is seven times the price. He stated that some of his direct-acting engines were now about to be constructed by makers who had formerly opposed their introduction, and that they had been made at a cost (including foundations) of 1720*l.*, as compared with the old engines of 3500*l.*, the engines being of equal power.

THE LATE THEATRE IN COVENT GARDEN.

ON the morning of Wednesday, March the 5th, the Theatre Royal Covent Garden was totally destroyed by fire. In addition to the magnificent style in which operatic performances have been produced at the late establishment, it is somewhat interesting to know that some of our most eminent representatives of the histrionic art have "fretted their dull hour," and delighted audiences who were in the habit of frequenting this once popular temple of the muses.

It has been remarked by some of the newspaper press, that the portico of the late theatre was a copy of that of the temple of Minerva at Athens, and by casual visitors to the scene of ruin that the interior resembled the Colosseum at Rome, and further, that the metropolis has been despoiled of a fine architectural adornment. The accuracy of this latter observation may, however, be fairly questioned, it being contended, that the façade of the theatre, facing Bow-street—the only part of the edifice which has any pretensions to architectural beauty—has too much the appearance of an enormous screen, with four huge pillars placed against it, without appropriate connection, and, but for the fine sculptures of Flaxman on each side of them, would present a very bald and ordinary piece of architectural composition. Again, the celebrated portico of the Parthenon is *octastyle*, and extends the whole width of the building, with its bold alto-relievo metopes, and sublimely conceived statuary which filled the tympanum of the pediment. It may also be added, that the columns, in an insulated arrangement, surrounded the whole temple, and, consequently, gave the structure all that importance which we have seen carried out in more modern works of celebrity,—such as the Madeleine, at Paris, and the town-hall at Birmingham, wherein the original Greek temple type is made the basis of the ground-plan in all its integrity.

With regard to the similitude of the ruined interior of the theatre to that of the Colosseum at Rome, every one who knows anything of the magnitude, plan, and general arrangements of that enormous and extraordinary edifice, must come to the conclusion that the parallel is absurd. The Colosseum covered nearly six acres of ground, was elliptical in plan, and could contain 80,000 spectators, and its outer wall was 187 feet high; it also suffered much by fire, but was repaired, from time to time, by the emperors; and, although in ruins, remains thus far as an illustration of the old Roman prophecy, which intimates that the destruction of the Colosseum, of the city, and of this world, will be together:

> "While stands the Colosseum, Rome shall stand;
> When falls the Colosseum, Rome shall fall;
> And when Rome falls—the world!"

The general dimensions of the theatre just destroyed were as follows, viz., the stage was 55 feet in length, and 86 feet in width; the depth from the curtain to the back of the pit, 66 feet, and the saloon 56 by 19 feet; the height from the stage floor to the ridge of the roof was 74 feet. The extreme external dimensions were 209 ft. 3 in. by 166 ft. 4 in.

The interior of the theatre was in a great measure rebuilt, and the fittings thoroughly re-constructed, by Albano, in 1846, when it was converted into one of the most elegant opera-houses in Europe, and capable of containing upwards of 3000 persons; the total cost of which was 23,000*l.*, and not from 40,000*l.* to 75,000*l.*, as erroneously stated by a portion of the daily press; and, from reliable evidence we have before us, the whole of the works were carried out in the most ingenious and

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effective manner, particularly as regards the substitution of *stone, brick, cement, and iron*, instead of wood, to the extent of upwards of 2000 feet of bond-timbering and door-lintels, which, although apparently sound on their external surfaces, were found to be decayed internally. This, added to the construction of two fire-proof staircases, for the safety of the audience, ascending from the Bow-street level up to the highest tier of boxes, with two fire-mains in each tier, seems thoroughly to exculpate Mr. Albano from any blame, arising from the hasty and inconsiderate observations that have been made in reference to the important duty which he peformed. It is also due to Mr. Albano to state that the acoustic arrangements of the theatre were made with such scientific skill, that the slightest sound issued from the stage could be distinctly heard in all parts of the house.

In reference to our subject, Mr. Timbs informs us in his highly interesting work, 'Curiosities of London,' that "Covent Garden Theatre, in Bow-street, was the second theatre of that name. The first was built upon part of the Covent Garden site by Shepherd, architect of Goodman's-fields theatre. Covent Garden was opened Dec. 7, 1732, by Rich, the celebrated harlequin. In 1746, Garrick played here. In 1803, John Kemble became the proprietor and stage-manager. On September the 20th, 1808, the theatre was burned to the ground, and twenty persons killed by the falling of the roof. Handel's organ, left by him to the theatre, was also consumed." So much for the old theatre; we now come to the structure which has just been destroyed. That was, we are told, the first production of Sir Robert Smirke, and for soundness of construction and general utility of purpose, has rarely, if ever, been surpassed. The first stone was laid by the late George IV. while he was Prince of Wales, December 31, 1808, and the theatre was opened September 18, 1809, occupying in its erection little more than eight months, and, considering the rapidity with which it was built, it is somewhat marvellous to behold the comparatively good condition of the walls, after having been subjected to such a fiery ordeal. In reference, therefore, to the brick, mortar, and cement portions of the building, we may affirm, upon the whole, that they have been as satisfactory as could have been wished; but, when we reflect that *two* of our metropolitan theatres have been destroyed by fire within the brief period of three weeks, it is believed that we have ample and just cause to complain of the very large use which has hitherto been made in our public buildings of combustible materials in their construction. We cannot, therefore, too emphatically condemn the profuse use of wood in all structures of a public nature, wherein large numbers of people assemble together; for, on looking over the conglomerated debris that presented itself after the recent fire, the suggestion occurs most forcibly to our mind, that it is most desirable some marked and useful improvements should be made without delay, in the construction, general arrangements, and facility of egress from all important buildings where the lives of the public may be placed in jeopardy. In considering this subject, it is deemed highly advisable that we should pay attention to the surprise recently expressed by some of our scientific French neighbours, to the effect that, with all our great resources, it is a cause of wonder to them that we do not use more extensively, in our building operations, those materials we possess and have at hand in such abundance, and which, to a very great extent, defy the action of the direst element in nature. Amongst those materials, of course, the most important one is iron, which it is presumed might be made available for most of the purposes for which wood has hitherto been so profusely substituted, with such lamentable results. It is therefore suggested that all roofs, ceilings, and doors, should be constructed of this material, instead of wood; and we see no reason why all the seatings of the boxes, pit, and galleries should not be of iron also, at least as far as the skeleton ground-work is concerned; in which case, should a fire occur, we would not, amongst other casualties, hear of falling roofs, ceilings and rafters, which have hitherto been composed of materials that add fuel to the flames of the devouring element, instead of acting in any way to check its direful effects. It is thought, therefore, that if iron were judiciously applied, in such a way that communications between apartments could be speedily cut off, and render them individually fire-proof—which, it is presumed, would require no very great stretch of the inventive faculties to accomplish,—much loss of life and property could be effected, and the importance of the subject seems to call for government assistance in the matter. But it may be urged, that both Sir R. Smirke and Mr. Albano, to guarantee the public from danger, took all that they thought to be necessary precautions against fire, and the former caused a tank to be erected on the roof of the theatre calculated to hold 18 tons of water, which, by means of double mains on every floor, could be thrown on any part of the building. This, of course, was all very praiseworthy, and very ingenious on the part of that eminent architect; but the evidence on the subject goes to show, that this wise precaution was rendered entirely abortive,—for, it appears that four firemen were appointed to watch and guard the theatre against fire, *whose duty it was to go over every part of the building, and see that the fire-mains were always accessible and always charged.* These men, instead of exercising the required vigilance in looking over the entire theatre, "confined themselves to the more congenial atmosphere of the stage," and never dreamed of a fire until the burning rafters came tumbling about their ears; and when it became necessary to turn on the water, the cocks could not be approached. Surely the cocks in connection with the water-mains throughout the building, with very little ingenuity, might have been so arranged as to permit their being turned on from outside of the building, as well as the inside.

The main object of the present paper is to call the attention of scientific men to the subject, and to show the necessity of a better mode of construction being adopted in all our public buildings; and in this we trust there is much hope, when we consider the great advances which science has recently made, to fill up this desideratum in engineering and architectural art.

It is highly satisfactory to know that the details of the roof of the late theatre, to a large scale, are preserved, through a recent survey, among the plates given in the "Examples of Building Construction," by Mr. Laxton, and will form valuable data to work from, not only in the roof of a theatre, but also for any public edifice where a large span is required to be covered,—of course, working out the details, as we suggest, in a material which is not combustible, and consequently of much less scantling, which would have another great advantage, namely, that of gaining considerably more room. We trust, therefore, that our scientific friends will lose no time in giving their serious and energetic attention to this most important subject.

THE NEW METAL, ALUMINIUM.*

MUCH attention has been excited upon the subject of the metal aluminium, and we perceive that many applications for patents connected with its use have been made. The ideas which originate these patents are, of course, based upon the presumed properties of the metal as detailed to us by the French chemists, with an additional colouring gained from the imagination of the inventor. It is superfluous to say that, under such circumstances, the results are but little likely to justify the expectations of the patentees; hence a few words of advice upon the subject may prove of use to the over-sanguine. The metal, so far from being almost as infusible as cast-iron, or even silver, melts more readily than zinc, and remains fluid upon a piece of dry wood, without sensibly burning it, as happens with tin or solder. It unites with scarcely any of the metals, and when united, in almost every instance loses its power of resisting oxidation; thus it affords no chemical protection to iron, as zinc does, but acts with it precisely as happens with tin, *i. e.*, the iron rusts wherever it is exposed to air and moisture; nor does the aluminium itself resist, under these circumstances, the same decomposing influences; on the contrary, it becomes rapidly coated with a white powder (alumina), and scales off. Tin and aluminium do not unite, but when brought into temporary contact by the intervention of another metal, the aluminium soon oxidises; with lead aluminium refuses to combine, though copper takes up a portion, and forms with it a bronze-coloured alloy. It may be made to unite with mercury, but the amalgam is very unstable, and soon oxidises. Upon the whole, therefore, we very much question whether this much-talked of metal will ever be of much practical use, except when employed in its pure state; and at present the high price of aluminium (more than 30*l.* per lb.) entirely excludes it from employment. It is indeed, every way probable that a cheap mode of manufacturing it will soon be discovered, and something of the kind is already whispered about; but until the event becomes a marketable fact, we see no reason to indulge in prospective hopes that aluminium will ever substitute tin.

* From the 'Journal of Gas Lighting.

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DEEP-SEA SOUNDING INSTRUMENT.*

H.M. steam-vessel *Spitfire*, off Sevastopol, November 13, 1855.

Sir,—Having for some time given my attention to the best means for obtaining correct soundings at great depth, and tried several appliances for this purpose, no instrument that I have ever seen or heard of equals, for ingenuity, simplicity, and neatness, the instrument I now bring to your notice by a model and drawing,—the latter of which accompanies this letter and description.

The inventor of this new and clever "Deep-Sea Sounding Instrument" is Carmelo Bonnici, a Maltese, and the blacksmith of the *Spitfire* since she was commissioned in 1851.

Several other instruments for this object having been previously made by him, in the course of the past year he produced the one now recommended for a fair trial in depths and conditions that do not occur in the sea I am now employed in. But it has answered perfectly in depths of 300 fathoms and under; and I have no doubt will answer equally well in any depth yet reached, where it is desirable for the weight to become detached on reaching the bottom, and not possible during its descent.

The advantage it possesses over the American instrument, of a rod passed through a shot, described by Lieut. Maury, U.S.N., and which has been so generally used by Lieut. Lee, in the recent voyage of the U.S. ship *Dolphin* in the Atlantic Ocean, is obvious at first examination, viz., in its application to any kind of weight that can be slung with a simple white line becket or loop. Thus, a pig of ballast, an old fire bar, or an elongated weight of any kind can be used; which, from its more rapid descent than a spherical body (a shot as used by Lieut. Lee, U.S.N.), possesses great advantages under circumstances of sounding where there is a superficial current.

With the instrument is used a small cup or hollow cylinder *a*, containing some arming to bring up an indication of the bottom. This is fastened to the instrument by a small wire or line *b b*, and is attached by the two projecting points *c*, that act as springs to grasp the end of the weight, if sufficiently pointed, or to a piece of stick lashed to the pig of ballast or weight for the purpose as *d*.

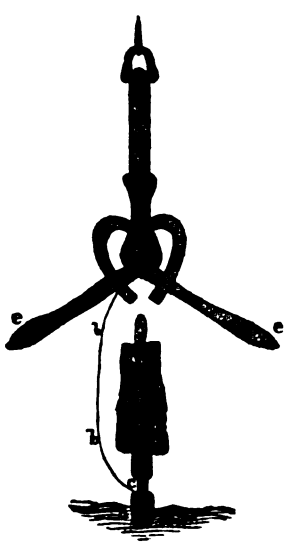


Fig. 1.

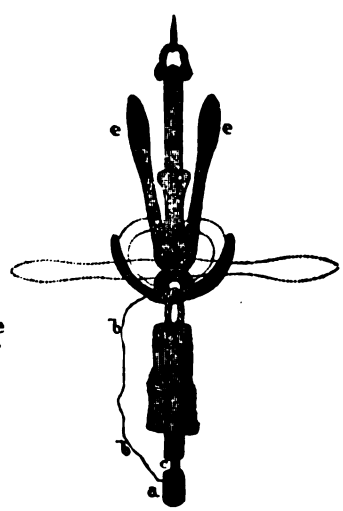


Fig. 2.

It will be seen that the weight is taken up by the instrument by placing the arms *e e* in the position shown in fig 1, so to open the double hook connected with the arms. And with the arms placed erect, as in fig. 2, the sinker is held by the instrument during its descent; but on reaching the bottom it becomes released through the two arms falling downwards by their gravity.

This instrument being one that may be of great use in every survey, I trust the inventor will meet the reward his ingenuity merits, and that it may be generally adopted in all our surveying vessels.

With this instrument and the use of a silk line I trust to be able to obtain the greatest depths that can be found in the Mediterranean or the Black Sea,———having nearly ten years since used a silk line for depths of nearly 1000 fathoms with great success; they being rapidly obtained, and not vitiated in any appreciable amount by the influence of local currents, or from the little friction offered, and the short time the weight is in consequence descending.

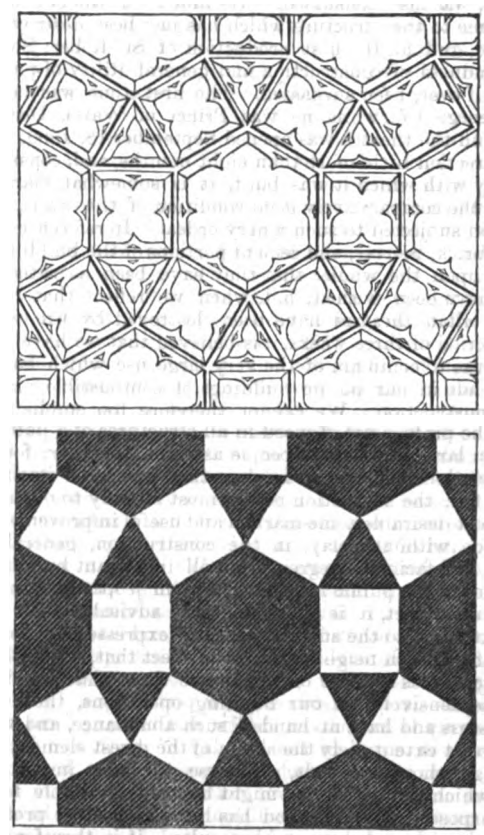
I am, &c.,

T. Spratt, Captain R.N.

Capt. Washington, R.N., Hydrographer to the Admiralty.

GEOMETRICAL COMBINATIONS.

Sir—I inclose sketches of a few of the various applications of a pattern formed by a combination of the hexagon, square, and equilateral triangle, which I believe to be a new one. It is peculiarly well adapted to tesselated pavements and mosaics, also for glazing with painted glass,—for the panelling of ceilings,—for the enrichment of cylindrical vaults and of domes,—for Gothic panelling in wood or in metal,—and for ornamental railings or gratings of iron or bronze.



The following are amongst the most effective combinations of colour, when the pattern is applied to tesselated pavements or mosaics:—

	Hexagon.	Square.	Triangle.
1	Red	Black	Yellow
2	Green	Red	Black
3	Blue	Yellow	Black
4	Red	Blue	Yellow
5	Black	White	Black

While acting on the Bombay committee for the selection of the Indian contributions to the Universal Exposition, I had specimens of this pattern prepared in the wood mosaic known as "Bombay work," which specimens are now in the Indian collection of the Palais de l'Industrie.

Henry Conybeare, C.E.

24, *Abingdon-street Westminster*

* From the 'Nautical Magazine.'

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RELATIONSHIP OF THE PICTURESQUE TO ARCHITECTURE.

[*Abstract of a Paper read before the Liverpool Architectural Society, by* Mr. Samuel Huggins].

There is nothing more characteristic of the feeling of the day than a rage for the picturesque, which was more or less influencing the design of everything erecting in the land. Almost every public building now rearing was divided and subdivided till all unity and simplicity was lost. A Gothic church was studded round with what had the look of being little more than labourers' cottages, seemingly with the design of disguising what little of interior unity it might possess; and even the chancel, which *within* was a continuation of the nave, looked externally like a huge scullery stuck upon its back. Church builders were affecting the low, humble proportions of the sequestered village church in the rough, busy neighbourhoods of great towns. So low were the side aisles in some instances that a ladder kept to mount the roof would have a sinecure situation; and as to the porch, a mischievous schoolboy might pull the slates off for pastime. Even a palace for the Queen could not be reared without the attempt to make it eminently picturesque. At Balmoral castle every paltry pretext was resorted to for breaking up the regularity of the lines and masses, and making the whole as like a group of almshouses as possible. Chimneys not long ago were foolishly hidden; now they were offensively obtruded, and made as prominent features in the front. But this was not the worst. He had observed the other day, in a published design for a college, the offensive protrusion of a chimney from one of the sides of a central and ornamental tower, when nothing would have been easier than concealing the flues within the thickness of the wall. These vagaries were perpetrated under the impression that the picturesque was the *sine qua non* of architectural perfection, which led him to the consideration of what this quality, which so much was sacrificed to obtain, really was. Picturesqueness was a quality with which the landscape painter, the figure painter of low and rustic scenes, and the painter of the lower animals, had chiefly to do. The picturesque was not what was good or beautiful in itself, but what was best suited for a picture. Time, weather, accident, vegetation, were prime agents for its production. Intricacy, nearly allied to confusion, indistinctness, were among the elements of the picturesque, which was made up of the time-worn, the weather-stained, the smoke-discoloured, the crumbling, the decaying, the defaced, and was indebted to whatever would break up the formal and systematic work of man. The sublime might be originated by design, because studied greatness would produce it; but the picturesque could not, inasmuch as it took a naturalness of form, of colour, and of texture, that only agents, over which the architect had no control, could give. We had our masters of the beautiful and our masters of the sublime; but nature was the sole exponent of the picturesque. The architect had to originate the graceful, the beautiful, the sublime, and leave the picturesque to its natural creators—to the causes that operated on the old buildings, which grew picturesque as nature's works grow picturesque—as we ourselves grow picturesque. An old man, with his gray locks, sunken cheeks, and bending form, was more picturesque than one in the hey-day of youth and beauty; but who was anxious for such picturesqueness? Every building should be uniform if there was nothing in its nature against it, because uniformity was a condition of perfection. In a dwelling house, where apartments were required of different shapes and sizes, and various offices diverse in every attribute of form, the whole naturally assumed an irregularity in outline; but what was there in a church to forbid complete regularity? In such a building, a vestry or other apartments were too insignificant, in proportion to the rest, to be allowed to mar the exterior simplicity and symmetry. He went at some length into an exposure of the various abuses which had arisen in the architectural practice of the day, from mistaken notions on the subject in question, and observed that, though his remarks had been very hastily thrown together, yet the views they embodied were not of hasty adoption; and it would be remembered by gentlemen present that he had more than once expressed them in conversation, more especially when visiting, in their company, some nine or ten months ago, the church erecting at West Derby, from plans of Mr. Scott, of London.

Discussion.—Mr. Frank Howard said the picturesque did not depend so much on colour as on light and shade. He considered the picturesque a very great feature in architecture.

Mr. Picton said there was a great deal of suggestive matter in the paper which had been read by Mr. Huggins, and often as he had been delighted with Mr. Huggins' papers, he did not know that he had ever heard him read a more happy one. He could not agree with everything advanced by the author; but with regard to the leading features, to the principles embodied in the paper, he unhesitatingly gave his cordial adhesion. He considered Mr. Huggins had been a little too hard on picturesque architecture. It frequently happened it would be the architect's duty to study the building with reference to its capabilities to form part of a picture. Claude and Poussin introduced bits of architecture into their landscapes to give a finish, and to carry the eye and mind of the spectator beyond the natural form of the landscape to something which possessed sympathy with civilised life, with mankind. At the same time, the forms were broken up so as to harmonise with the natural features of the landscape. That being so, did it not appear necessary and natural, when they had to deal with similar landscapes in reality that they should adopt the same principle in adapting their buildings to them. Building Gothic churches, such as Mr. Huggins had described in large towns, where they were surrounded by more lofty buildings, was worthy of all the ridicule which he had showered down on it. On the whole, he was inclined to think that in the present day there had been too much straining after the picturesque, especially amongst Gothic architects. Perhaps others might have been to blame, but it appeared to him to be the crying sin of the day with regard to Gothic architects. Failing in new forms or new developments, which none of our modern Gothic architects appeared to have the courage to take up, their only resource was to break up the masses and dribble the ornaments about. There were many honourable exceptions. He differed from Mr. Howard essentially as to colour not forming any portion of the picturesque—technically he was wrong, but practically he was right; and he considered when the New Zealander stood on the broken arch of London-bridge, the ruins of St. Paul's would then look even more picturesque than they now did. Mr. Huggins had gone very near to the point of the true source of the picturesque; but it was an inferior quality when applied to works of art. It did not call from them sympathies of the higher class. When they said a building was sublime, it raised their thoughts above them; if beautiful it called up tendencies and visions of something inexpressibly touching to the mind, but of a higher character than naturally exists there. When they spoke of the picturesque, it came to be more familiar to them; it was a lower class of sentiment than the sublime or the beautiful. He could not understand a building realising abstract beauty; it was rather concrete beauty. He hoped the paper would be printed; it was a very creditable and suggestive essay, and one for which he felt much indebted to Mr. Huggins.

Mr. James Hay could scarcely go to the same extent as Mr. Huggins in the condemnation of the picturesque, because he thought in most of our finest buildings there would be found something of the picturesque. Take the Greek temple, the severest form of architectural composition. The finest view of it was taken at an angle, so as to get the west end of it, as it were, and the front. In a picture the same held good. Even in the disposition of the Greek building, which was the severest, they did not study symmetry so much as they were apt to think. Fergusson pointed this out as an erroneous notion. The approaches were always at an angle, purely studying the picturesque. He contended that irregularities could not be avoided in colleges and other buildings, though he admitted that there was a certain amount of art in the distribution of those buildings. Irregularities could not be disregarded in the village church, and he conceived that they might with propriety have a south porch without having a north one. A building should indicate externally as much as possible its internal arrangements, and stairs carried up in the thickness of the walls could not be shown externally, and the stem of a chimney might be made a feature beautiful in itself, or as a balance to something else.

Mr. Rimmer held that a building must originally be picturesque, otherwise time could not make it so; and he did not agree that Gothic architects always had this in view. Sawney Pope-street was as much disarranged as any Gothic church, but that street was the very reverse of picturesque; and Birkenhead was the least picturesque place he ever saw when it was half finished.

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Picturesqueness seemed to him to be the art of putting the right thing in the right place, and he hoped Mr. Huggins would extend the signification of the word.

Mr. VERELST said the comparison of the chancel of a Gothic church to a scullery was unjust. A chancel was a thing which was wanted, and outside he thought it improved the appearance of the building. It was a balance to the porch, and broke the outline. The chancel improved the appearance at the east end of the church far more than it could do at the straight end. As there was generally a tower at one end, it would break off very suddenly at the east end, but the chancel graduated it, and he considered it a great improvement. He considered it a fallacy to say that a church with aisles ought not to be built in a crowded town, because it was overtopped by other buildings. He denied that there was any want of propriety about the new palace at Balmoral. It was in the style of architecture practised by the nation where it was situated; it was sturdy, and seemed to him to agree with the general character of its situation. Sebastopol would be picturesque, not as a matter of picturesqueness, but from the associations connected with it; but when he compared it to any work of architecture not in ruins, it seemed to him that the comparison did not hold good. Picturesqueness was not naturally in colour, and he was of opinion that the term could not with propriety be applied to a pigsty. Picturesqueness applied more to outline than to colour, and he doubted whether some things were not more picturesque when new than they were at present. Flying buttresses were matters of utility, and many buildings would not sustain the roof if it were not for flying buttresses. [In support of this view, Mr. Verelst exhibited a design of the roof of Notre Dame]. He denied that the Egyptian architecture was picturesque.

Mr. COX said the pyramids were considered by many to be picturesque, and he asked what it was they owed it to—whether it was colour, light or shade, or form? They were homogeneous in form and mass. There was light and shade, and there was a great amount of picturesqueness in the colour alone, and there was one striking confirmation of it in an eastern mosque. There was a round mosque at Cairo, the mosque of the Sultan Hassam, which, architecturally, could hardly be said to be beautiful, picturesque, or sublime. It was a vast mass of buildings, literally four high walls, elevated above the surrounding squalid buildings; but those walls were harmonious in colour, owing to the mosaic work and a variety of coloured stone let into the flat surface of the wall, and when seen against a blue sky it had a most pleasing and picturesque appearance. The eye dwelt on it with pleasure; and that building owed its picturesqueness almost entirely to its colour. The Tombs of the Kings were also renowned for their picturesqueness. They were Moorish in their architecture; their colour was a brown hue; and they were exceedingly pleasing when contrasted with the vast expanse of glaring sand and the blue sky. This was owing more to their sombre colour than to either their form or architectural beauty. He agreed that there was a great deal of picturesqueness in light and shade as well as in colour, and it might be artificially applied to produce an effect. The easterns were convinced of this, for their mosques and minarets were painted with large stripes of red and white, and in the bright light this had the most pleasing and picturesque effect to the eye. They had no architectural charm; colour alone had given them their charm.

Mr. HUGGINS replied that most gentlemen had mistaken what he had stated with reference to the picturesque. He did not say it was not a quality of architecture. He asserted it was a quality which architects had nothing to do with. They were not to seek it. It was a quality that would come, but it would come unbidden. The various elements mentioned by Mr. Hay were involved in what he said, that a course ought to be pursued according to the purposes of the building. It was perfectly ridiculous to say that colour was not an important element in picturesque after the testimony of Mr. Cox. He did not object to the protrusion of the chimney, but making it offensively prominent over the principal entrance was perfectly ridiculous. Stair-turrets projecting out were inadmissible. He had not seen Sebastopol, but no artist would go there to paint a picture. What he said was that fifty years would show what bombs and shells could do for art. The buttress, he said, was eminently picturesque, and he took this as an example to point out that they were not beautiful. The Egyptian temples were picturesque, but this was not gained by any studied irregularity. The pyramids were not picturesque; they were too angular. He never asserted that time alone would make a building picturesque. He did not object to the chancel showing over the east end of the building, but he objected to it assuming so disjointed an appearance; it had no unity in connection with the body of the building. He was surprised at Mr. Verelst's ideas of the picturesque. They were not held by any artist; they were not his (Mr. Huggins's) and never would be.

ON GENERAL AND SYSTEMATIC METEOROLOGICAL INQUIRIES.

By THOMAS HOPKINS, M.B.M.S., and Vice-President of the Manchester Literary and Philosophical Society.

METEOROLOGICAL inquiries are generally made through the means of certain instruments, particularly the barometer, the thermometer, and the hygrometer, which show alterations in atmospheric pressure, temperature, and humidity. Registration of the movements of these instruments has furnished a considerable amount of information relative to the changes which are so constantly taking place in that aerial ocean, the atmosphere in which we live. But notwithstanding the improvements that have been made in the instruments, and that certain courses have been adopted in making observations, no system has yet been devised which, treating meteorology as a science only imperfectly developed, aims at increasing our knowledge of it as *a science*. Facts have been collected with great care and industry, apparently under the idea that they must throw light on the subject; but nearly all kinds of facts have been accumulated with equal care, and without due reference to laws with which they are undoubtedly connected; the facts, therefore, have too much the character of a chaotic mass.

But meteorology has now reached a degree of development which invites us to inquire into what are the best means that can be adopted to assist and improve our future investigations of the subject; and before we decide on those to be preferred, we should have as clear a view as we can obtain of the precise object sought to be accomplished. This object is, it is submitted, a knowledge of the laws of nature which produce the changes that take place in the atmosphere. Meteorological instruments are means by which we observe and virtually interrogate nature, while changes are taking place, for the purpose of discovering, not facts alone, but laws also which in their operations give birth to the facts. And as we obtain glimpses of these laws we may use them in such a way as appears the most likely to increase our knowledge, and to furnish us with such a clue in subsequent inquiries as may assist in conducting us through the labyrinth of facts in which we are at present involved *

The first inquiry then which we have to make, may be—What law is at present recognised, as operating to produce the great alterations that so constantly take place in the atmosphere? What causes the fluctuation of atmospheric pressure, as indicated by the barometer?—What sets the air in motion in such way as to produce strong winds?—What makes one part of the atmosphere very humid, and another part, not far distant, very dry?—Why are some parts of the earth almost constantly deluged with rain, and other parts never visited by it? In order to answer questions like these, certain hypotheses have been advanced which recognise the existence of principles or laws. One of these hypotheses is, in substance, that the sun heats the surface of the globe, and consequently that portion of the atmosphere which is near the surface, in different degrees in various parts, and thus by partially increasing temperature destroys the equilibrium of atmospheric pressure, and gives birth to winds of the various degrees of force that are experienced. This has been called "the Temperature Theory," and it includes not only the general Hadleyan theory of the great tropical and polar aerial currents, but also those assumptions that have been made of the different effects produced by the direct action of the sun on large continents and on the ocean, and consequently on the atmosphere over each of these portions of the surface of the globe.

This hypothesis is so far recognised by meteorologists of the present time as to be adopted as a theory, and to be practically taken as a guide in their investigations; it is, therefore, inter-

* The Astronomer-Royal has recently stated, that "after having obtained the immediate results of observation with the utmost completeness and exactitude, we are absolutely stopped from making further progress by the total absence of even empirical theory."

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woven with their observations to such an extent as to give a bias and particular direction to their inquiries, and it may be presumed to lead them unconsciously to give undue prominency to what appears to be the most in accordance with their prepossessions. If it operates thus, its influence may possibly be opposed to the increase of knowledge and the extension of science, and it becomes desirable that observers should be put on their guard respecting this possible source of error.

In the 'Atmospheric Changes which produce Rain and Wind,'* it has been attempted to show that all the great movements of the atmosphere are attributable, not alone to the unequal influences of the sun's direct action on different parts of the surface of the globe, but, in the first place, to the action of solar heat in vapourising water, and then to cold in the higher regions of the air condensing the vapour. The sun, in accordance with this view, is admitted to be the primary source of motion and change in the atmosphere,—not, however, through its direct influence in heating the surface of the earth, but through the indirect processes of evaporation of water and condensation of vapour. And it is contended that meteorological inquiries may be conducted in such a way, as to determine whether the former or the latter of these hypotheses is more in accordance with the operations of nature. If the former should be found to be so, we may hope to be able to trace the great disturbances of atmospheric pressure, as indicated by the barometer, to direct heating of the surface by the sun, and we may endeavour to follow that heating through intermediate agency to the barometric movement. The great changes of atmospheric pressure might then be observed with relation to the localities of known heated surfaces, and the intermediate parts might be carefully examined in order to discover the nature of the connection.

But if such inquiries should furnish facts that do not harmonise with the hypothesis, it may be permitted to the observer to suppose that it may be unfounded, leaving him at liberty to pursue his investigations in a different direction, and adopt, if requisite, the second hypothesis, which is called "the Condensation Theory," as a guide, and ascertain how far the facts harmonise with it. The adoption of some hypothesis is suggested because it is likely to become a clue to the inquirer, where no path presents itself; but it ought not, and need not, prevent such facts being noted and recorded as seem to be opposed to it. The discovery of laws and the establishment of a theory being the object, we endeavour to test the hypothesis, and prove whether it be true or false. In either case, knowledge will be advanced. We either detect falsehood or establish truth; and if falsehood should be detected, we are at liberty to take up some other course of investigation, without being bewildered by the *ignis fatuus* that had previously crossed our path.

This being admitted, what then are the inquiries that it is desirable should be made in the pursuit of our object?—and in what manner should they be conducted? There appear to be two modes of proceeding. We may either direct our attention to those phenomena where nature operates, in a palpable way, on a large scale, and with great power; or to those processes that she carries on in a more concealed manner, but with superior regularity and constancy. We may also follow both these courses, and ascertain how far the results obtained from each of them harmonises, not only with the general operations of nature, but with the other.

In the former class of phenomena we may inquire into the circumstances that accompany storms, when the falling of the barometer shows a great reduction of atmospheric pressure in the part, as well as into those appearances and changes which precede and attend the great winds that sweep over extensive portions of the globe. In the latter and more conceded class, we may endeavour to trace the various changes which are associated with the horary fluctuations of the barometer, and the daily sea and land breezes that are found in many parts of the world. And if it should appear that laws are in operation, under different circumstances, which produce both classes of the phenomena, it will furnish ground for submitting the evidence thus obtained to more rigid examination, should it not be considered by all parties sufficient to establish the truth of the hypothesis.

First, then, with respect to those storms that greatly disturb atmospheric pressure, as indicated by extensive changes in the height of the mercurial column of the barometer. These may be often observed in many parts of the world over both land and sea; observations may therefore be made, so full, as probably to throw much light on the subject. The appearances in the heavens which so generally give notice of the approach of the storm, should be carefully watched, and the most remarkable of them minutely described,—such as the appearance of clouds, their forms and densities, as indicated by their degree of blackness, as well as their motions. The movements of the barometer should be registered at the same time, and the precise periods of their occurrence carefully recorded, in conjunction with the times of changes in the sky, the height of the part above the level of the ocean being, if possible, ascertained. The instant when the barometer begins to descend should as nearly as possible be ascertained, with the appearance of the sky at the same time,—whether it was becoming misty, or whether the clouds appeared to be darkening. The time when rain begins to fall, either in the part, or near to it, should also be recorded, as well as the character of the rain-fall, its violence, quantity and duration, in conjunction with the other phenomena; a leading object being to ascertain whether any, and, if any, what connection exists between the first formation of rain in the atmosphere or its fall on the earth, and the movements of the barometer. It has been often observed that, as the storm was increasing in violence, the barometer ceased to sink, and even began to rise: the time of such rise should be carefully recorded. After a storm has continued for some time, hail occasionally falls; the time of this fall should also be noted, as well as the size of the hail-stones. Thunder and lightning will not fail to be noticed.

Continuous winds do not present as good a subject of meteorological inquiry as storms. It is not easy to discover precisely where a wind begins; we can therefore do little more than observe its direction, strength, and temperature, together with its humidity and dryness. The direction of a wind is generally described by naming the quarter from which it comes. This, of course, indicates the part towards which it goes; but it appears desirable that observers should have their attention specially directed to the localities towards which it seems to be blowing. Those who say that all winds in the lower part of the atmosphere blow towards heated surfaces, must be presumed to desire this; as it would point out, and fix attention upon, the place in which they consider that the cause of the motion of the air may be found. And an endeavour on the part of the observer to name, in each case, the particular locality towards which the air appeared to him to be passing, would accustom him to making efforts to connect the wind with its immediate cause. Such a course of observations could hardly fail to present important considerations to those who adopt the first hypothesis, and therefore it may be presumed that that course would meet their approbation.

Others, who think that winds have a different origin, must equally desire to have the locality pointed out towards which the wind seems to blow; but they may also wish to have the general meteorological character of the place described towards which it blows. Is it a surface-heated tropical region, or is it land outside of the tropics that is heated by the sun in summer? If it is either the one or the other, it may be easily pointed out, as such places are well known to geographers, and may be easily referred to by observers. But, in order to test more fully the second hypothesis, winds should be, as far as possible, followed to their termini, in any part of the atmospheric space, either near the surface of the earth, or to a height in the atmosphere. The terminus of a wind may possibly be found over any part of the globe where cloud is formed or rain falls, and, therefore, over the sea; it may, consequently, be difficult to do more than simply record the direction of the wind. But that record may be accompanied by general registrations of the strength of the aerial current below, the temperature and humidity of the air, and the state of the sky in the locality; leaving to others the task of ascertaining the condition of the atmosphere in the distant part toward which the wind was blowing. In this way, returns obtained from different ships, if properly digested and arranged, might show that in the part towards which winds had been blowing at a particular time, clouds were forming or rain was falling; and the strength of the wind might be shown to be connected with particular alterations that were going on in the atmosphere in the part towards which the wind blew. Simple formation of cloud might thus be found to be connected with light breezes, moderate rains with more decided winds, and heavier falls of rain and hail with storms. Even what are called cyclones, which have recently engaged so much attention,

* London: Weale. 1855.

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might possibly, in this way, be followed, and the state of the sky described in the part of the atmosphere where the wind appeared to terminate. We might then be informed what clouds are seen within the cyclones, or, when seen in profile from a distance, the appearances of the clouds in their outer parts,—what rain falls within them or in their neighbourhood, and in what part of their neighbourhood. Intelligent observers might record such facts as, when compared, might throw a strong light on that which is now involved in much darkness But even if such results were not obtained, the observations might show that our knowledge of the laws of nature could not be increased by such means, and, therefore, that endeavours ought to be made in some other direction.

On land, the task of the observer of winds is less difficult. As has been stated, if winds blow towards heated surfaces, they may be easily connected with such surfaces. And if they blow towards areas of condensation, the character of each area may be ascertained and shown to be the probable terminus of the wind. And even when irregular winds blow, sometimes in one direction and sometimes in another, as often occurs, a good record of them may enable inquirers, from information obtained from different quarters, to connect them with equally irregular appearances of cloud and falls of rain in certain other places. This may not be an easy task in slight and changeable breezes, but in more decided winds it may be found possible; and in hurricanes on land, the wind may generally be traced to, or nearly to its terminus, either in the lower or the higher part of the atmosphere. At the place where it is found to end, the state of the sky should be carefully scrutinised, and the meteorological condition of the atmosphere in the part be ascertained, for the purpose of determining whether the air that had been moving had stopped and become still, or had *inosculated*, as is sometimes asserted, and ascended to upper regions. And the appearance of the sky should be minutely described, with the character of the clouds, and, if any, the falls of rain, either in the part itself or in the immediate vicinity. Water-spouts and cyclones should be watched, the state of the lower air at the time ascertained, and the clouding of the part immediately over the site of the phenomena be carefully and minutely described, with any fall of rain or hail that may then take place.

But there are other winds that blow over land with considerable constancy in the same direction,—it is therefore easy to trace them to their termini. Are such termini heated surfaces? If they are, let them be pointed out, and connected with the winds that blow towards them, and thus accumulate evidence of the connection between heated surfaces and winds blowing towards them. On the other hand, if such winds blow towards and terminate in cloudy and rainy localities, let the facts be given that bear on the subject in proper connection with each other. If this were done, it may be presumed that, in no long time, all the winds included in the classes under consideration would be treated of in connection with their immediate causes, and it would become evident to all persons that their termini were either in rainy localities, or in parts the surfaces of which were much heated by the direct action of the sun, instead of the subject remaining in its present obscurity.

Some of these continuous winds blow over sea as well as over land, but it is presumed that they all terminate near to, or over, land; and the inquiry in these cases is, also, as to the character of their places of termination. Are they heated surfaces or rainy districts? To ascertain the place of termination of each of these winds with considerable exactness, and to make ourselves acquainted with its meteorological peculiarities, would seem to be not a difficult task. They would constitute interesting inquiries into those phenomena that accompany great changes of atmospheric pressure, and the principal winds that sweep over the surface of the globe. And if such inquiries should be made in addition to ordinary meteorological investigations, the results would probably be satisfactory.

But there are other operations of nature which are carried on in a more concealed manner, to which attention may be advantageously directed. These evidently arise from the diurnal motion of the earth presenting, successively, different parts of the surface of the globe to the action of the sun, thus producing daily sea and land breezes, and hourly changes of atmospheric pressure. There are many parts of the world, principally on sea coasts, where daily and nightly winds are found. In these places, about some one hour in the morning a wind begins to blow from the sea to the land, continues to blow during the day, and ceases towards night. In a short time afterwards a land wind springs up, which continues through the night. At the same time, in these places, the mercury in the barometer rises twice and falls twice, showing that there are four changes in the atmospheric pressure in twenty-four hours. The changes both of the winds and the barometer are, by meteorologists, generally said to result from the sun heating the surface of the land, more than that of the sea, which causes the land air to become relatively light, and to ascend in the day. In the night the air is said to cool and descend, in accordance with the principles recognised in the first hypothesis or "the Temperature Theory." There are, however, many objections to this hypothesis, some of which have been stated in the 'Atmospheric Changes which produce Rain and Wind and the fluctuations of the Barometer,' particularly in the first five essays, where it is attempted to be shown that the alterations of both winds and atmospheric pressure are due to condensation of vapour in the morning, and cloud evaporation in the evening.

Considerable care and labour will, however, be required if the subject is to be fully investigated, as hourly observations should be made in the different parts. But as such have already been registered in many places, they may be deemed not impracticable. An hourly registration of the barometer will show the changes of atmospheric pressure, and that of the thermometer will exhibit those of temperature; but in addition to, and simultaneously with them, the movements of a protected wet-bulb thermometer should be given, as well as the dew-point. The changes in the directions and strength of the wind, and in the clouding of the sky, will complete all the registrations that are necessary. But an account of the nature of the country may be added,—whether it is hilly, and if so, how far the hills are from the sea; if the country is flat, whether wet or dry.

The daily changes are found to be the most considerable within the tropics. The barometer generally begins to rise some time after 4 a.m., and continues rising until 9 or 10 a.m. It then falls until about 3 or 4 p.m., after which it rises a second time until about 10 p.m., and then falls a second time till 4 a.m. In these movements the range of the mercury seldom reaches half-an-inch. The dew-point being registered with the barometer, will show what part of the general atmospheric pressure is attributable to the elastic force of vapour, and what is due to the weight of the gases. But the hourly movements of the dry and wet bulb thermometers, and the clouding of the sky, should also be given with equal care. The sea and land breezes vary much in the times of their occurrence, and those times should be observed in each place, in connection with the character of the neighbouring country,—its flatness, or its hilly nature, and the distance of the hills from the sea.

These diurnal changes should, if practicable, be observed on every coast, both within and without the tropics, wherever traces of them may be found. But particularly on the coasts of Hindoostan, from Calcutta to Cape Comorin, and by the western coast to the delta of the Indus, and even into the Persian and Arabian gulfs. The eastern and western coasts of Africa, with the character of each part, whether marshy, flat and dry, or hilly, may be observed, as well as the whole of the American coasts, and the islands of the West Indies;—also the islands of the Pacific ocean, and of the East Indian Archipelago. From Norway, the coasts of the British Islands, and other parts of Europe, wherever these daily fluctuations can be detected, it is desirable to obtain returns; even if partial they are likely to be useful.

But attention may be particularly directed to the neighbourhood of Bombay, Poonah, and the Mauritius, from which places registrations have been received of the horary fluctuations of the barometer; but accounts should be furnished also of the simultaneous alterations in the dry and protected wet-bulb thermometers, and in the strength and direction of the wind. Similar particulars would also be interesting of the country about Mahabaleshwar, in which more than 300 inches of rain have fallen in a year, and of Chierra Poonje, where 600 inches have fallen.

The registered facts will of course be tabulated, but it would add to their utility if accompanied by diagrams, such as those given in numerous meteorological returns, exhibiting the times and degrees in straight lines, and the hourly changes by dots connected by lines, thus showing in curves the risings and fallings of the instruments, on the plan adopted in the Plymouth Meteorological Report, by Sir W. S. Harris, which is known to many persons.

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INSTITUTION OF CIVIL ENGINEERS.

Feb. 19 & 26.—ROBERT STEPHENSON, Esq., M.P., President, in the Chair.

ON MENTAL CALCULATION.

Mr. BIDDER said he was permitted by the President to deviate from the ordinary course of proceedings, and to address the members orally, instead of committing his views to paper; indeed it had been the difficulty of satisfactorily describing, by the comparatively slow process of writing, operations of the mind which were infinitely rapid and comprehensive, that had hitherto prevented his attempting a task which he felt to be, in some degree, incumbent upon him; as it would be affectation on his part not to admit the great advantages he had derived from the power of mental calculation, which had given him a rare and unusual facility in dealing with numbers.

It was, however, the circumstance of one of his oldest and best friends occupying the presidential chair that had finally determined him to attempt to convey to the members the process of reasoning, or action of the mind, which constituted the power of mental calculation; and in doing this he must ask the indulgence of the meeting for assuming some points which, though clear to him, might not be so evident to them. Those, however, he would finally endeavour to elucidate, when he had laid before them his general views.

He was convinced that mental calculation could be taught to children, and be acquired with greater facility and less irksomeness than ordinary arithmetic; although, of course, a child in whom there existed a predilection for calculation, would even then be as remarkable, and take as prominent a position as in the acquisition of any other subject.

The class of eminent mental calculators had been extremely limited, and within the last two centuries might be restricted to a few names, among whom Jedediah Buxton and Zera Colborne were the most remarkable; but even their powers had not been usefully employed, in consequence of their not having subsequently had the opportunity of receiving a mathematical education. It might be assumed, from the small number of persons who had thus distinguished themselves, that a peculiar conformation, or quality of mind was essential; and it had been the received opinion that mental calculation was an art naturally engrafted upon peculiarly constituted minds; it had also been attributed to the possession of great powers of memory; indeed, it was, he believed, the general impression, that he was indebted to unusual powers of memory and a natural mathematical turn of mind, for any celebrity he had acquired. Now he would emphatically declare, that this was not the case;—he had sought every opportunity of comparing himself with boys and men who possessed this faculty, and excepting so far as being carefully trained and practised in the cultivation and use of figures, he did not find that his memory was more than ordinarily retentive. In fact, whilst at school and at college, he had some difficulty in maintaining a decently respectable position in the mathematical class.

Before entering more minutely into the subject, it was necessary to enunciate, as a principle, that there was not any royal or short road to mental calculation; the processes were, like all others in arithmetical computation to be performed seriatim, as whatever might be the number of figures employed in a calculation, they were only so many symbols to be dealt with precisely as they would be exhibited in algebraic formulæ, with which the calculations might be considered as identical. In point of fact, many of the processes of mental computation, if produced on paper, would appear most prolix and complicated. They could however be accomplished mentally, in consequence of the faculty of occupying the mind simultaneously with the double task of 'computing' and of 'registering.' The first—computing—was executive, or reasoning, and was that portion of the process which, whilst it was the most active, was not that which caused the greatest strain on the mind. When it became necessary to record the result, the second faculty—registering—was called into play. Now it was this latter occupation of registering that was the real strain upon the mind, and by which alone the power of mental computation was limited.

The phenomena connected with the powers of memory deserved careful attention; the remarks on this point might not be original, but they were necessary to complete the argument.

In infancy the first active operation was learning to talk, or ascertaining the significance of a few words; then the letters were acquired; then their combination into written words, and finally their arrangement into sentences. Thus, there was gradually accumulated an extensive vocabulary of words and facts, imperceptibly stored away in the mind, but always ready for action.

In reading a page of letterpress, it was obvious that each and every letter was observed, arranged into words, and then combined into sentences, to appropriately express a definite meaning. Now, in the case of figures, a mind, properly trained, had a number of facts stored away, so that when any calculation was to be performed, the mind, unconscious of effort, summoned the exact fact at the instant when i was required, dealt with that fact according to circumstances, and presented it to the memory for registration. These phenomena might be aptly compared to events in nature; such as when in a dark and stormy night the whole landscape was illuminated by a flash of lightning; although only during an inconceivably short period, it sufficed for the mind to perceive one or more objects, and to receive a definite impression of their form and position.

In comparing the process of writing, on a literary or scientific subject, with that of thinking for calculation, it would be seen, that an author would first frame the outline of his argument, or description, in his mind; but, that operation once performed, the mode of expression, in committing it to paper, could be varied to almost any extent. Not so, however, in reasoning connected with numbers;—in registering them, the figures must be recorded in their exact value and sequence, or the result would be valueless. Experience had shown, that up to a certain point, the power of registering was as rapid as that of thought; but the difficulty increased in a very high ratio in reference to the number and extent of impressions to be registered, until a point was reached, where registration in the mind and by writing were exactly balanced;—below that point mental registration was preferable,—above it, that by writing would be as quick and be more certain. Therefore the mental process, as compared with the operation of writing, was as the speed of lightning to that of an express train; and if the power of registration could be maintained at all times upon a par with the executive faculty, there would be no difficulty in computing, with immense rapidity, a table of logarithms up to 10 places of figures.

The difference of multiplying upon paper 3 figures into 3 figures, as compared with multiplying 6 figures into 6 figures, was as the squares of the numbers of the respective figures, and the time required was as 4 to 1. Now, in mental computation, the time required was more probably as 16 to 1. It was not pretended that this power or faculty of registration could be accurately described by any mathematical expression, but it would convey some idea of the labour to say that it exceeded the fourth power as compared with the square. There could not be any hesitation in stating that the real utility of mental computation was limited to the multiplication of 3 figures into 3 figures. Mr. Bidder had, as a *tour de force*, multiplied 12 figures into 12 figures, but the mental labour of registering was excessive. If then, the actual utility was so limited, there was no doubt that it was capable of being taught to any boys of average capacity, with as much facility as the principles of common arithmetic.

The multiplication of 2 places of figures into 2 places of figures, was performed in the mind so rapidly, and with so little consciousness of effort, that it had been generally supposed Mr. Bidder held, recorded in his mind, the results of the multiplication table up to that extent; careful investigation had, however, shown that the whole process was worked out mentally in each case, though with almost inconceivable rapidity.

The earliest exercise of the mind should be a familiarity with the value of numbers; and it was to this early power of dealing with numbers, as possessing a definite significance, that the eventual facility of computation was due. All the rules employed by Mr. Bidder were invented by him, and were only methods of so arranging calculation as to facilitate the power of registration; in fact he had arrived at a sort of natural algebra, using actual numbers in the place of symbols.

A boy, as ordinarily taught, would write down and multiply mechanically $3487 \times 3273 = 11{,}412{,}951$ without attaching any particular value to the sums, or to their relation to each other; and in performing the operation of multiplication, he would commence by the units, and arrive at the result, believing it from habit to be correct, but without having by any mental process convinced his reason. It would be a strain upon any mind to remember for any length of time the figures 3487; the mere figures not possessing any significance, or presenting any stated value to the mind, beyond that of a code signal transmitted by the electric telegraph, which might be remembered, but could only be comprehended by those who had the key.

Now in early youth Mr. Bidder adopted the diametrically opposite course of proceeding; he knew the positive and relative value of 1000 before he could express it upon paper; and by cultivating this definite impression of certain values, his mind was schooled to embrace and appreciate numbers, however large they might be; whereas in the ordinary mode of teaching arithmetic, the simple digits could not convey any definite meaning, or leave any permanent impression upon the mind. The difference between the two systems was as great as that of the mechanical repetition of the letters of a page, and the comprehension of the sense they would convey.

After these preliminary observations, Mr. Bidder proceeded to trace chronologically his own progress in the attainment of the power of mental computation.

He believed it was in about the sixth year of his age that he first began to deal with numbers; he had not then learned to read, and certainly long after that time he was taught the symbolical numbers from the face of a watch. His earliest recollection was that of counting up to ten, then up to 100, and afterwards to 1000; then by intuitive process he taught himself the method of abbreviating the labour of counting, arriving, in fact, at the natural multiplication of numbers into each other, attributing to each a separate and individual value.

In this manner the actual value of every number, up to 1000, was impressed on the memory, and he then proceeded onwards seriatim up to a million. It was his practice to count numbers practically with

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peas, marbles, or shots, to compose rectangles of various values, and by counting them; the multiplication table was ultimately the result of actual experience and test, and he attained an intimate acquaintance with numbers multiplied with each other, by a tangible process, divested of that formidable character under which it was generally brought before the young student.

In this way he learned to multiply up to two places of figures before he knew the symbolical characters of the figures, or the meaning of the word "multiply," as instead of the term "multiplying 27 by 73," he only understood the expression "27 times 73."

All the varieties of numbers up to a million being represented by 6 different designations, or varieties of numbers, viz., units, tens, hundreds, thousands, tens of thousands, and hundreds of thousands, their permutations were only 18 in number. A boy who knew his multiplication table up to 10 times 10, registered 50 facts in his mind, and with the 18 permutations above mentioned, had only to store 68 facts. The ordinary multiplication table of 12 times 12 gave him 72 facts to store, or 4 additional facts. The machinery, therefore, necessary to enable him to multiply to 6 places of figures consisted of 4 facts less than that required to enable him to carry the multiplication table in his mind.

The application of this, when fairly acquired, might be thus illustrated; for example, multiplying 173 by 397, the following process was performed mentally:—

100×397=39700
70×300=21000=60700
70× 90 ... = 6300=67000
70× 7 ... ... = 490=67490
3×300 ... ... = 900=68390
3× 90 ... ... = 270=68660
3× 7 ... ... = 21=68681

The last result in each operation being alone registered by the memory, all previous results being obliterated.

To show the aptitude of the mind by practice, he would know at a glance, that ... ... 400 × 173 = 69,200
and then ... ... 3 × 173 = 519

the difference being ... ... 68,681 as above.

It would be seen by this, that the mind adopted a system of natural algebra, which might be thus amplified:—calling the above numbers $(a + b + c) \times (d + e + f) = ad + ae + af + bd + be + bf + cd + ce + cf$; the mind registering the additions at every step, to leave the memory charged with the least possible amount of facts.

Distinguishing between the mental operations of 'computing' and 'registering,'—he particularly pointed out, that the facility of computing depended upon the mind having a store of facts, which it could command, without effort, at the instant when required, and that the registering power was that which limited the extent to which mental calculation could be carried;—that the whole of the devices he had adopted, and to which he had been driven, all originated in the necessity of lessening the strain upon the faculty of registration. Generally, he strongly insisted on the mind being accustomed to numbers and quantities, before it was encumbered with the symbols by which they were represented. From the remarks of some who had heard his introductory remarks, and who had since been induced to apply the system then recommended, it appeared, that the principal difficulty they found, was in being unable to recognise the numbers, except symbolically. Now, the principal difference between the symbols and their signification really arose, chiefly from the habit of trusting to symbols. Take, for instance, the number 763. These figures were three separate ideas, not having any connexion with each other, whereas the number or quantity 763, was really only one idea or one quantity, just as the word Hippopotamus, though compounded of five syllables, conveyed but the idea of one animal, just as the monosyllable Cow represented one animal. Now if the animal Hippopotamus was conventionally signified by 1, 7, 5, 7, 4, more difficulty would be experienced, inasmuch as the figures had no relative connexion as to position, nor any relation to the object signified. In fact, numbers should not be an abstract idea, but should be embodied into a real signification—or rather, the dry bones of figures should be clothed, just as the dry application of a word was clothed with meaning, when its significance and distinction were considered, as in the case of the word Hippopotamus, in itself an awkward word and difficult to be recollected, unless it was known to mean a 'river horse.'

It had been pointed out that, within certain limits, the power of registration almost equalled that of the reasoning faculty; next, that, beyond this, the difficulty of registering increased so rapidly as practically to place a limit to the useful application of mental computation; and, as far as could be judged, this limit was confined to the multiplication of 3 figures into 3 figures.

In describing the process of mental multiplication, it had been shown that the system adopted was to diminish the strain on the memory by retaining only one result at a time, and it would have been observed from the previous remarks, that this would be the leading principle throughout the whole range of mental arithmetic.

It was intended, in continuation, to make a few remarks on addition, subtraction, and division,—then on the rule of three, applied to money, weight, measure, and time—then on the square and cube roots, compound interest, and prime numbers, with instances of their application to subjects connected with the profession of civil engineering, concluding with what would appear to be the true course of education in teaching arithmetic.

With regard to addition and subtraction, it would be perceived, that the same principle, as already explained for multiplication was adhered to, viz.: that of commencing with the left-hand side, or the large numbers, and adding successively, keeping one result only in the mind. This had the further advantage, that the moment the large figures were operated upon, the mind was no longer charged with them, and they might be dismissed, as it was no longer incumbent to register them. Now, the mere getting rid of this feeling, of its being necessary to charge the memory with them, set the mind free to continue the rest of the operation; it did not follow that he *did* forget the sums or figures to be dealt with, still, getting rid of the feeling of the necessity of accurately recollecting them was of manifest advantage. Some examples, both of addition and subtraction were then given.

Division was, as in ordinary arithmetic, much more difficult than multiplication, as it must be a tentative process, and was only carried out by a series, more or less, of guesses; but no doubt, in this respect, the training arrived at by mental arithmetic gave the power of guessing, to a greater extent than was usually attained, and afforded a corresponding facility in the process. Supposing, for instance, it was necessary to divide 25,696 by 176, the following would be the process;—100 must be the first figure of the factor; 100 times 176 were known at once to be 17,600; subtracting that from 25,696, there remained 8096; it was perceived that 40 was the next number in the factor; 40 times 176 = 7040, there then remained 1056—that, it was immediately perceived, gave a remaining factor of 6, making in all 146; thus only one result was retained in the mind at a time; but as contrasted with multiplication it was necessary to keep registered in the mind two results which were always changing, viz.: the remainder of the number to be divided, and the numbers of the factor, as they were determined; but if it was known, as was the case in the present instance, that 176 was the exact factor without any remainder, having got the first factor—100—which was perceived at a glance: it was known that there were only four numbers, which multiplied by 76 could produce a result terminating in 96, viz.: 21—46—71—and 96, and, therefore, the immediate inference was, that it must be 46, as 121 must be too little, and 171 must be too much, therefore 146 must be the factor. Thus, as before observed, the only facility afforded by mental calculation was the greater power of guessing at every step towards the result.

In treating of that which was ordinarily described as the rule of three, it was proposed to take the whole subject under consideration at once, as applied to lineal measures, weights, money, and time. The mode of treating all these was essentially the same; and as being most convenient it was taken as applied to money, as an index of the general mode of proceeding with respect to all. Now, in dealing with this department, which generally consisted of dealing with so many pounds weight, yards of measure, or days' work, at so much per item, if it consisted of £ *s. d.*, the process commenced with pounds, and having obtained that result, the shillings were next treated, reducing them into pounds, and adding them to the previous result, and so on to pence and farthings, keeping, however, only one result in the mind at a time. This was exemplified by the sum:—787 at 14*l.* 15*s.* 6¾*d.* worked out by the process described.

But the mind acquired a facility in these calculations, far beyond what had been expressed, by the acquisition of certain facts, in such a way as to have them under command at all times, and to be available, when it was obvious that they would shorten the calculation. Of course constant practice immediately enabled Mr. Bidder to demonstrate, by absolute proof, that in a pound there were 960 farthings, and 240 pence—as that there were 48 farthings and 12 pence in a shilling. Also, that a mile consisted of 190,080 barley corns—63,360 inches—5280 feet—or 1760 yards; and the year equally consisted of 31,536,000 seconds, 525,600 minutes, or 8760 hours. Now the result of this was, that on being called upon to ascertain the number of seconds in 87 years—instead of having to multiply 87 by 7 and then by 52, and then to interpose 87 days, to make up for the odd day in each year, and then to multiply the result by 24 and then by 60, and this again by 60—the way of proceeding was at once to multiply 87 by 31,536,000. Even upon paper this would be found to be a considerable reduction in the number of figures required, and mentally it afforded great assistance; inasmuch as the mental system required only 22 figures, whereas, by the ordinary system, the result could only be arrived at by 59 figures.

In lineal measure, the same system was adopted in showing the number of barley corns in 587 miles.

These facts would not, however, be of any use, unless they could be recalled without any effort, and of course that could only be attained by the facts being imprinted in the mind, under such circumstances as rendered the impression permanent, and this could only be accomplished by the mind working out the result itself and being thoroughly satisfied with the demonstration. The mind having thus become imbued with these facts, as to money, time, and weight, as soon as Mr. Bidder became acquainted with the relative value of the integers,—pounds,

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shillings, pence, and farthings,—he immediately applied himself to resolving the pounds and shillings into farthings, the day into minutes and seconds, the week into hours, minutes, and seconds, and the year into days, hours, minutes, and seconds; the mile into yards, feet, inches, and barley corns, and the ton into pounds and ounces; and having ascertained these facts by actual and obvious proof, they became indelibly registered in his mind, to be always at hand when required.

Square and Cube Roots.—Perhaps there was nothing in which the mental process caused greater astonishment, than in resolving the square and cube roots,—more particularly the latter,—and perhaps in none was it less entitled to occasion wonder, because it partook more of 'sleight of art,' than of any real power of mind, or of any real useful application of means; as would be apparent on considering them. It was at about the age of somewhat less than twelve, that Mr. Bidder was first asked to extract the square root; but before he could comply with the requisition, it was necessary to explain to him what the square root meant, and this was explained by showing that 400 was the square of 20, and 20 was the square root of 400. As might be expected, all who tested his powers were generally prepared with the means of ascertaining the accuracy of his answers. Now it was well known that the easiest application of multiplication, was in squaring numbers, and was much more easy than extracting the roots; the consequence was, that those who propounded the questions squared or cubed a number, and then gave the result, whence to extract the root, and if the answer agreed with the number they started with, they were satisfied. The consequence was that nearly every example proposed was a true square or cube: hence the following expedient was hit upon. It appeared, on reflection, that whatever might be the two last figures of a true square, as for instance 61—could only be produced by the square of four numbers, viz: 19—31—69—81; hence if called upon to extract the square root of 337,561, Mr. Bidder knew instantly that 500 must be the first part of the root, because 10,000 was the square of 100; hence that the hundreds in the square root of 330,000 would correspond with the digits in the square root of 33, viz., 5 or 400 in the larger denomination. Ascertaining this, he had to choose between the four other numbers to ascertain the remaining term of the square root, and he was enabled at a glance to perceive that it must be the larger number—81—from the fact that 81 was to 100 (the difference between 500 and 600), nearly in the proportion of 87,000 to 110,000 (the difference between the square of 500 and 600). As regarded the terminal 25, the square of all numbers ending in 5 terminated in 25—hence it would seem, that the choice lay between all the numbers ending in 5 up to 95; as, for instance, in extracting the square root of 442,225, of course, as before, it would be known that the first term was 600, but although the square of all numbers ending in 5 would always terminate in 25, yet there was this guide, that numbers ending in 5, 45, 55, and 95, had no hundreds interposed after the thousands; as, for instance, the square of 155 was 24,025—then the square of numbers ending in 15, 35, 65, and 85, terminated in 225; as, for instance, the square of 185 was 34,225; and again, numbers ending in 25 and 75 terminated in 625; as, for instance, the square of 125 was 15,625; therefore with regard to the root of the proposed number, it must lie between the numbers 15, 35, 65, and 85, and from the proportion of the excess of the proposed number over the square of 600, it was evident that it must be 65, therefore it was concluded that the root was 665.

Now, as to the cube root, it was still more simple, because as regarded the even numbers, there were only two terminal numbers which would produce the last two places of figures in a true cube; as, for instance, 76 could only be produced by a number terminating in either 26 or 76.

As regarded the old numbers ending, for instance, say in 17, if it was a true cube, the root must end in 73; so that, on being called upon to extract the cube root of 188,132,517, it was known that as the cube of 100 was 1,000,000, and as the cube of 5 was 125, and the cube of 6 was 216, therefore 500 was the first term of the root; and, as there was but one number which being cubed would produce 17—viz., 73—it was inferred that the root was 573; and this remark applied to all the roots ending in odd numbers, with the exception of those ending in 5. With regard to these, the choice lay between those ending in 25 and 75; for instance, the cube of all numbers ending in 5, 25, 45, 65, and 85, terminated in 25; all those ending in 15, 35, 55, 75, and 95 terminated in 75. Therefore, on being asked to extract the cube root, say of 180,362,125; as before, the first number was known to be 500, and then the choice lay between 5, 25, &c., and to obtain a clue to the result the course was to cube 550 approximately, and the cube of this being 166,375,000, it was immediately perceived that it must be 565.

Where the numbers were suspected not to be true cubes, after obtaining the result upon the assumption that they were so, the process was to test them by the "nines."

In the case where the cubes were not true, the results were approximated by testing and taking differences. It would, therefore, be perceived that as regarded the extraction of the roots there was no real practical value, excepting under certain exceptional cases.

Compound Interest.—It need scarcely be said, that without the aid of logarithms there was hardly any calculation more laborious than that of compound interest, being in fact the raising of a number with a fraction to any assigned power; and, as taken in this way, it was an expanding series, no term could be safely neglected; therefore in performing this operation, the strain was so great that it was necessary to devise the means of abbreviating the process and lessening the strain upon the memory, and the mode of reasoning adopted in this case was rather curious, as indicative generally of the system pursued in mental investigations.

Supposing it was required to calculate the compound interest upon 100*l.* at 5 per cent. for 14 years. First it must be considered as a case of simple interest. This would, therefore, be $14 \times 5 = 70l.$ Next, that each 5*l.* as it accrued, carried also simple interest—the first 5*l.* would bear interest of 5*s.* per annum for 13 years—the second 5*l.* for 12 years, and so on. This was, therefore, the reverse of the series $1 + 2 + 3$, etc., Now, curiously enough, this was a series, the nature of which Mr. Bidder had investigated in reference to the common question of the "100 stones at a yard apart," and it was difficult to conceive the delight he experienced as a boy, in becoming acquainted with some of the beautiful properties of numbers, and he therefore knew, at once, that the summation of the series was equal to $14 \times 13 \div 2$, or as expressed algebraically, assuming,—

$$a \text{ to be } 14 = \frac{a \times (a-1)}{2} \times 5s. = 22l.\ 15s.$$

this added to $70l. = 92l.\ 15s.$ Now having done this, he considered all the 5*s.* put out at simple interest, and then similarly ascertained that this was represented by the following series:—

$$1 + 3 + 6 + 10 + 15 + \text{etc.}$$

The different terms of the previous series, already discussed, were 1, 3, 6, 10, 15, and therefore each term of the former series corresponded with this last, and their summation was thus:—1, 4, 10, 20, 35, 56. Now dividing each term of the summation by the corresponding term of the series composing it, the following relations were perceived:—

$$1\ 1\tfrac{1}{3}\ 1\tfrac{2}{3}\ 2\ 2\tfrac{1}{3}\ 2\tfrac{2}{3} = \tfrac{3}{3}\ \tfrac{4}{3}\ \tfrac{5}{3}\ \tfrac{6}{3}\ \tfrac{7}{3}\ \tfrac{8}{3}$$

from this it was immediately inferred, that the summation of the interest of 5*s.* at 5 per cent, viz., 3 pence, was expressed by

$$\frac{14 \times 13 \times 12}{2 \times 3} \times 3 \text{ pence} = 4l.\ 11s.$$

this added to $92l.\ 15s. = 97l.\ 6s.$ Now this series was expressed algebraically by

$$\frac{a \times (a-1) \times (a-2)}{1 \times 2 \times 3} \times \frac{100}{(20)^3}$$

Having perceived this sort of law, the remaining were easily discovered terms; thus the interest upon the 3*d.* was thus expressed:

$$\frac{14 \times 13 \times 12 \times 11}{2 \times 3 \times 4} \times \frac{3d.}{20} = 12s.\ 6d.$$

this added to 97*l.* 6*s.*, gave 97*l.* 18*s.* 6*d.*, and so on; the next addition being 1*s.* 3*d.*, making 97*l.* 19*s.* 9*d.*; the next term gave $1d. = 97l.\ 19s.\ 10d.$; perceiving how rapidly the series converged, and that the remaining terms could not by any possibility make up one farthing, the process was stopped, and the result was given as 97*l.* 19*s.* 10*d.* It would be seen, therefore, that instead of 14 processes, this result was arrived at in 5 operations, and which admitted of a much easier computation than was apparent from the above.

Prime Numbers, it was hardly necessary to say, were those which had no relation to those below them, as they were insoluble, having no factors. Mr. Bidder had struggled against hope in trying to discover if any law of sequence was attached to them, but all in vain. It only remained, therefore, to determine the easiest means of ascertaining whether a number was prime or not, and to discover its factors, if any. With this view, of course, the first step, if a number was even was to continue dividing it by 2 until the result was an odd number, then adding the digits together and seeing whether it was divisible by 3, and, if so, to divide it until it was insoluble by that factor; after that, all clue as to the component, or factors, if any, of the number was lost. Now the obvious process of testing this, was by taking the nearest square root of the number, and then dividing by all the primes up to that point; viz., by 7—11—13—17—19, etc. This was a process involving great labour, and occupying much time, where the numbers were large. To abbreviate this process a plan was adopted, arising from the following considerations. The number being odd the factors must, of necessity, be odd also; they could therefore be expressed algebraically by $a + b \times a - b$. This multiplying was therefore expressed by $a^2 - b^2$; hence no prime number could constitute the difference between two true squares, excepting those which were one-half below and one-half above its moiety. Now this enabled to be tested, mentally, very rapidly whether the number was divisible by the primes nearest the approximate square root, and which, being the largest, where the most difficult to divide by. For instance, suppose it was necessary to ascertain the factors, if any, of the number 3139; the nearest square above that was 3249, the root of which was 57, now, 3249 exceeded 3139 by 110, which was not a true square; the next square above that would be the square of 58, which would be 115 ($115 = 57 + 58$) more to be added to $110 = 225$.

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Now this was a true square, of which the root was 15; hence it was seen that the factors were $58 + 15 = 73$, and $58 - 15 = 43$. Therefore, by this simple process, the necessity was avoided of dividing by 53, 47, and 43, which were the primes between the square root as above, down to the actual factor, viz., 53, 47, and 43; but, as could be shown, there was a point where this process offered no advantages; at that period, therefore, no plan was left but to divide it by all the primes in succession; therefore the primary object was to ascertain whether the number was divisible or not. The plan adopted was this; assuming the number to be tested was 23,141, and it was wished to know whether it was divisible by the prime number 79. Now, the only number which, being multiplied by 79, would produce the terminal 41, was 79, and 79×79 was 6241; this, taken from 23,141, left 16,900; then if 16,900 be divisible by 79, so was 169, which it was not, therefore that could not be a divisor. The next prime, 73, was then tried; now, the only number which, being multiplied by 73, and which would result in 41, was 17, and $17 \times 73 = 1241$, this deducted from $23,141 = 21,900$; but as 219 was evidently divisible by 73, it was evident that this was divisible, and that the factors were 73 and 317. Contrasting this with the ordinary mode of proceeding, the economy of effort must be obvious.

Mr. Bidder contended, from his own experience, that a facility in using mental arithmetic, combined with an intimate knowledge of the laws of mechanics, must necessarily prove of great utility to the civil engineer; so far as regards himself it had materially aided his individual career—it had aided him in times past, in suggesting matter for cross-examination, and, as might be imagined, had proved very embarassing to the witness.

The first occasion in which he was engaged in parliamentary proceedings, was as the assistant of the late Mr. H. R. Palmer, in opposition to the Liverpool and Manchester Railway Bill. On that occasion the advantages of this power of mental calculation were so evident, that a suggestion was made in the Committee before the Lords, to prevent him from being present during the investigation.

Another instance was on the Northampton and Peterboro' Railway Bill. Whilst under cross-examination, a question arose as to the retention of the flood-waters on some land above a bridge on the railway. The counsel, relying upon the next to impossibility of giving instantly a definite answer, inquired the length of time during which the water would be retained above the bridge. Now this, with the power of mental calculation was very simple. Assuming the area to be about 200 acres, or 9,000,000 superficial feet, at an average depth of 3 feet, gave a cubic content of 27,000,000 cubic feet. The fall being 3 inches through the bridge, and the area of the opening 1000 feet, the velocity might be assumed to be 2½ feet per second, and it was easy to ascertain that the water would be run off in about three hours. It was certain that the learned counsel did not expect a definite answer, and as certain that he could not test the precision of the reply; nevertheless a *bona-fide* calculation was made, and all that remained for the learned counsel was to ask whether the number of fish passing through in the same time could be given with equal facility.

An instance of practical utility would be this: A fact to be registered in the mind was, that approximately 220 cubic feet of water would flow per minute through a pipe of 12 inches diameter, at an inclination of 1 in 100. Now from this fact there was no difficulty in ascertaining, approximately, the quantity of water flowing through any sized pipe, at any inclination. Assuming the inclination of a pipe of 3 inches diameter to be 1 in 400, the general law of hydraulics demonstrated, that the velocity would be reduced one-half by the lesser inclination, and one-half by the lesser diameter, the two combined reducing it to one-fourth in velocity; and the diameter of 3 inches as compared to 12 inches, giving an area of one-sixteenth, the result would be that the flow would be reduced (approximately) to one-sixty-fourth, or be about 3½ feet per minute.

It was not recommended that the engineer should rely implicitly upon this mode for ascertaining the details of his plans or designs, but it would enable him, in times of leisure, to arrive at the outline of his plan, in the same manner that the artist prepared the rough sketch of his picture, and subsequently filled in the details.

It was perhaps scarcely necessary to say more on this portion of the subject; but it might still be well to give a short *resume* of the general views of the application of the system to education. The first step that Mr. Bidder would recommend, even before any knowledge of figures symbolically was acquired, was that the process of counting up to 10 should be mastered, then to 100, and subsequently to 1000; then the multiplication-table, up to 10 times 10, should be taught, practically, by the use of peas, marbles, or shot, or any bodies of uniform dimensions, by placing them in rectangles and squares.

Having thus induced the student to teach himself the multiplication-table, nothing would be more easy than to teach him to multiply 10 by 7, which would be $10 \times 10 + 10 \times 7$; having accomplished this the multiplication of 17 by 13 would easily follow, being $10 \times 17 + 3 \times 10 + 3 \times 7$. This being executed, it only remained for him to practice multiplication up to two places of figures. Concurrently with this should be taught the permutation of 100, 1000, etc., into each other, and thus would be laid the basis of mental calculation, for whatever extent the individual might desire to carry it to; but the early training should be such as to enable the student to rely upon his own resources for framing his rules for any other branch of arithmetic. In order to do this, however, his mind must be stored with a certain number of facts, which must be completely at his command, and advantage should be taken of the mode of giving him, if such an expression might be used, an insight into natural algebra and geometry. With this view the training should be extended, and there would be no difficulty in conveying to young minds the knowledge of certain leading facts connected with the sciences, long before they were capable of comprehending the beautiful trains of reasoning by which their truths were established. There was no difficulty in impressing, permanently an appreciation of the relative proportion of the diameter to the circumference of a circle; of the beautiful property of the square of the hypothenuse of a right angled triangle, being equal to the sum of the squares of the two sides containing the right angle, or of the equality of the areas of triangles on the same base, contained between the same parallel; and many others which must occur to all geometricians.

The same with respect to the properties of several series of numbers: for instance, $1 + 3 + 5$, &c., or $1 + 2 + 3$, &c., or $(1) + (1 \times 6) + (1 + 3 \times 6) + (1 + 6 \times 6,)$ &c.

The task proposed had been accomplished; but before he ceased to occupy the attention of the Institution he had a few remarks to make of a more personal nature. Although his path through life had at times been rugged, yet, from the beginning to the end of his career, kind and sterling friends had ever been ready to help him in times of need;—in early youth, in more mature manhood, and up to the present moment, when he was addressing the meeting in the presence of one to whose friendship he was, in a great degree, indebted for the position he now enjoyed. It had not been, however, his lot to pass through life without provoking some unfriendly feelings, and on candidly reviewing the past, he could not help thinking that this might, to some extent, be due to those early habits of self-reliance which possibly had appeared to take the form of want of consideraiion for the feelings of others; but he hoped that with many of these, and especially with such as were members of this Institution, with which he had been associated for upwards of thirty years, his active career would not close, without establishing more amicable feelings. In conclusion, he remarked, that should the observations he had made tend to any practically useful result, it would be mainly owing to the cordial, kindly, and sympathising spirit with which the members had received him, and listened to his observations.

March 4 & 11.—ROBERT STEPHENSON, Esq., M.P., President, in the Chair.

The Paper read was "*On the Causes of Explosions of Steam Boilers.*" By WILLIAM KEMBLE HALL, United States.

The different theories advanced to explain the action resulting in explosion were examined and illustrated by the ordinary attendant facts. Inherent defects in design and material were sufficiently provided for, by the preliminary testing and the ordinary safety-valve, and the deterioration by use could be guarded against by periodical examination. If the pressure of the steam was allowed gradually to increase, until it exceeded the strength of the boiler, the danger would be betrayed by some one of the numerous rivets and seams of its structure, as there was always some single point which would first give way. In the boiler which exploded on the 18th of August, at the Hartford Steel Works, Sheffield, the steam was at its usual working pressure of 40 lb. per square inch, when a rupture took place in the side of the boiler, from which the steam issued with a furious hissing sound, warning the attendants of their danger and enabling them to escape. The side-stays were defective and had failed. It was reasonable, then, to suppose that the tearing of the boiler into several pieces, which generally accompanied explosions, was caused by a sudden exertion of power, and electricity had been suggested as an agent. But although electrical phenomena might be exhibited by the expansion of a jet of steam, it could not be supposed that a boiler, with its many direct and metallic connections with the earth, could be converted into a reservoir of electricity. If any were generated it would be instantly conducted away. It had been supposed that the plates exposed to the action of the fire by the falling of the water had become overheated and decomposed. The steam, the oxygen of which had combined with the iron, and the hydrogen, formed a gas that had caused the explosion. But hydrogen would not explode, unless largely mixed with atmospheric air, which could not enter the boiler, except in minute quantities, forced through the feed-pump in combination with water; and although there was evidence of the absorption of oxygen in the rusting of the stays and of the interior surface of old boilers, it was too insufficient in extent to warrant the deduction that there had been an appreciable change in the chemical composition of the steam. It might be possible to produce an external explosion, but not an internal one.

In the explosion at the Consett Iron-works, Gateshead, early in November, it was in evidence that the boiler had been blown out a short time previous, and the valve was not closed. The plates had been heated red hot, and it was supposed that the attendant, who was killed had discovered the deficiency of water, and had just opened the feed-valve at the instant when the explosion occurred. Now heat did not lessen the strength of iron up to the temperature of 550°, and had it exceeded that point in this case, and thus weakened the boiler, the result

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would merely have been a collapse of the flue. Water was not resolved quickly into steam by a red-hot surface. The excessive heat repelled the particles, and they were slowly evaporated by the communication of heat through the intervening vapour. No great pressure, therefore, could have been generated directly from this source. When heat was applied to steam the increase of its pressure was governed by the same law that applied to air and all other elastic gases, an addition of 480° only doubling its pressure. Experiments had conclusively proved the possibility of heating steam in contact with water without also increasing the temperature of the bulk of the water, the upper stratum of which alone became heated by the contact. If therefore it was supposed, for example, that the steam had been heated to 435° Fahrenheit, and water suddenly injected into it, the pressure would have been instantly raised to that due to the presence of the water, determined by the experiments of Arago and Dulong to be 360 lb. per square inch at that temperature; or, to use another illustration, while 1000° of heat applied to steam would but increase its pressure or volume about three-fold, the same amount would multiply that of water 1700 times. This vast increase would certainly be modified by the latent heat absorbed by the water in its conversion into steam, but served to indicate a sudden and local generation of excessive pressure, which might result in explosion.

The surcharged steam might be supplied with water, without the agency of the feed-pump. At the explosion which occurred at Chiswick, July 16th, when the safety-valve was in good order, and loaded to the average working pressure of 20 lb. to the square inch, the boiler had been idle during the dinner hour, and the explosion occurred as the engine-man was in the act of opening the stop-valve, preparatory to starting the engine. The water had probably been low, and the sudden flow of steam into the pipes partially relieved the water of pressure, and it was thrown by the agitation into intimate contact with the superheated steam; and suddenly converted into vapour of too high a tension for the strength of the boiler. It was a well-known fact, to those conversant with the practical management of steam boilers, that the water stood higher when the engine was in operation than when it was idle, and that it might be further raised by opening the safety-valve. This effect was more apparent with a contracted water surface and comparatively small steam-room. An explosion which took place at the Tower Mills, Sheffield, August 11th, was an illustration. The surviving attendants positively affirmed that observations of the water-guages, a few minutes previous to the accident, showed sufficient water; but an engineer, deputed by the coroner for the purpose, examined the boiler, and testified that it had been overheated, and that such indication was wrong, or had been misunderstood. The boiler exploded immediately after the attendant had made some preparation necessary for opening the safety-valve, and probably at the instant he had opened it. The boilers that exploded at the Walker Iron Works, at Newcastle, October 8th, and at the Kebblesworth Colliery, September 19th, were each provided with a float and two safety-valves. In both instances there was reason to believe that the water had been forced through the connecting feed-pipe from the boiler that exploded into the adjoining one, and that in the latter instance the attendant had observed the danger, and was engaged in opening the safety-valve.

Experience had proved that the fusible metal plug enjoined by law in France became encrusted by scale, and otherwise rendered inoperative by use, and did not answer the purpose for which it was intended. The softer portions of a compound metal were forced out by the pressure to which it was subjected, and the remainder becoming oxidised did not fuse at the temperature intended. It moreover acted merely as a warning, and did not serve to obviate the impending catastrophe.

All the contrivances hitherto adopted for the purpose of providing against explosions were designed to supply water, when that in the boiler had fallen to too low a level, or to open the safety-valve by the pressure of steam, independent of other circumstances. As had been illustrated by the examples alluded to, either of these plans would induce, in many instances, the very accident designed to be avoided. For there seemed every reason to believe that the great majority of explosions were occasioned by the negligence of the attendant in permitting the level of the water to fall below the flues, exposing the plates to a high temperature, and surcharging the steam with caloric, far exceeding that due to its pressure. In injecting an additional supply of water into the boiler when in this dangerous condition it was thrown over the heated plates and into the super-heated steam, and suddenly converted into steam of too high a tension for the boiler, and so instantaneously, moreover, that it operated with all the momentum of a blow. And as the water necessary to produce this disastrous result might be supplied to the surcharged steam from that already in the boiler, by the agitation incident to the opening of the so-called safety-valve, the alarming fact was presented, that the very instrument provided for insuring against explosions might become the cause of producing one.

These considerations naturally led to the conclusion that safety was alone to be attained by opening a water blow-off valve, when the surface of the water had fallen to a perilous extent, for the purpose of first discharging from the boiler the water, which was the more dangerous element, and then the steam, operating, in fact, as a safety-valve in a more useful but less objectionable position than the present steam-valve situated on the dome. The arrangement represented by the wood-cut (fig. 1) illustrated the principle; it represented a valve communicating with the water, and kept in a position by a rod which served for its stem, and terminated in a button cemented with tin, or other readily fusible metal, into a copper cup riveted to the crown of the furnace. There were no working-joints or stuffing-boxes to become disordered, and the fusible metal was protected by the cup, composed of a material which was a rapid conductor of heat. If the furnace should be unduly heated the button would be released, and the valve permitted to open and discharge the water and steam from the boiler. The boiler might be injured, and the flues destroyed by the fire, but no explosion could occur. This system had been subjected to trial under heavy pressure, and had been found very successful.

The accompanying illustrations will explain the apparatus more fully, and its application to boilers differently constructed.

Fig. 1 is a section of an ordinary cylindrical boiler with a single internal flue fitted with this apparatus. Fig 2 is a side elevation of the apparatus as applied in the preceding figure; *a*, is a valve communicating with the water in the boiler by a pipe; *b c d e*, is a rod serving as a stem to the valve *a*, made in two parts jointed at *d*, for convenience of construction, and terminating at its lower end *e*, with a button or flange; the upper end *c*, of this rod or valve-stem is cut with a screw thread and furnished with a nut, by which the valve may be secured tightly in its seat; *f*, is a cup, bolted or otherwise, fastened to the upper portion of the flue, in which the valve-stem *c d e*, is secured with tin or any other readibly fusible metal alloy or other compound. When the tin in the cup *f*, is melted, the valve *a*, is opened by the pressure of the steam, and the water and steam discharged from the boiler through the pipe *b*.

The cup *f*, should be made of copper or other good conductor of heat, and should be placed in the position first exposed to the action of the heat, by the falling of the surface of the water, or in any other position where by malformation of the boiler or otherwise the plates are most likely to become unprotected, by water, from the action of the fire; *g*, is a washer of vulcanised india-rubber placed under the nut on the valve-stem by which the valve is secured to its seat for the purpose of compensating by its elasticity for any difference in the expansion of the boiler and its flue; and the valve-stem *h*, is a pipe by which the water and steam, when discharged from the boiler, may be employed to extinguish the fire or conduct it to any other part that may be desired; the pipe *b*, may also be used as the outside feed-pipe from the force-pump.

Fig. 3 represents the application of the invention to a boiler with external flues.

Fig. 4 shows its arrangement when applied to a boiler with two internal flues.

Figs. 5 and 6 show a form of the cup *f*, for holding the fusible metal with which the valve-rod is secured in a manner different from that shown in figs. 1 and 2.

Fig. 7 is a modification of the joint *d*, in the valve-rod *c d e*, by which the inequalities of expansion may be compensated for by the elasticity of the joint-pin, independent of the ring of vulcanised india-rubber represented at *g*, in fig. 1. The same purpose may be accomplished by the use of an ordinary helical spring.

Mr. Hall, in the specification of his patent, does not claim any of the mechanical parts separately, nor does he confine himself to the precise combination of the valve, fusible metal, cup, and intervening elastic substance as above described, as they may be varied without departing from the nature of the invention. But he claims the connecting of a valve with an apparatus that insures its opening when the boiler becomes dangerously overheated, whereby the water and steam may be discharged from the boiler employed if desired to extinguish the fire.

Discussion.—It was argued that Mr. Hall's system, if properly carried out, would be extremely useful, and almost prevent the possibility of danger from explosion; but that it would be of use only when an explosion was almost inevitable, and that as prevention was better than cure, the utmost should first be done to prevent boilers reaching that state, still retaining Mr. Hall's valuable apparatus, in cases of all other means of prevention proving ineffectual. The majority of explosions were stated to arise from the practice of constructing the boilers with the fire-places in the flues, contrary to the system used in Cornwall, where they always arranged to have abundant boiler room and slow combustion, but where flue firing was used the boiler surface was too frequently deficient; and the firing rapid and generally forced. Plans were exhibited showing this peculiar danger to be caused by the severest action of fire being of necessity within the concavity of the fire-flue, upon which there was but a few inches depth of water, and where the least neglect in its supply would be fatal to the boiler plate, even if a repulsive action did not already cause a remittant rather than a constant action of contact of water with the plate; besides which, the probability of the water below the fire bars, not boiling at all, rendered the supply of steam weak and easily exhausted, and led to undue firing and all its concomitant evils. The furnace constructed of masonry was described as promoting the reverse of all these conditions. Many extracts from known writers bearing on the subject were given, and it was attempted to be shown that while there were fully as many under-firing, as tube-firing boilers at work, the

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Hall's Patent Safety Valves for the Prevention of Steam Boiler Explosions.

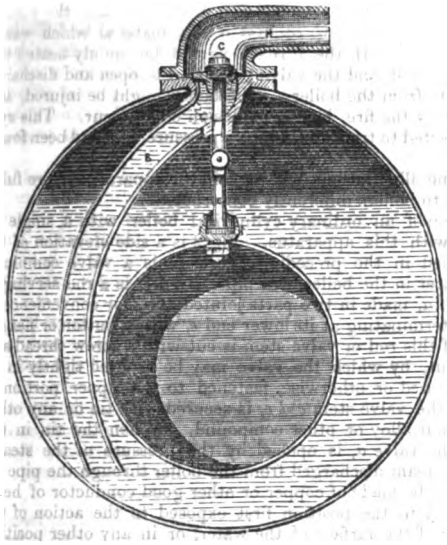


Fig 1

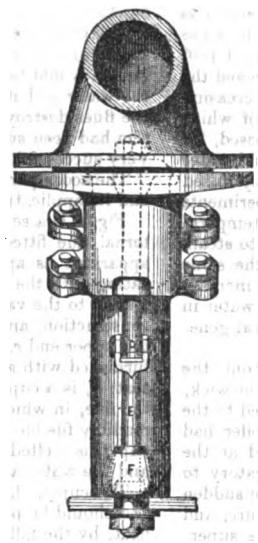


Fig 2

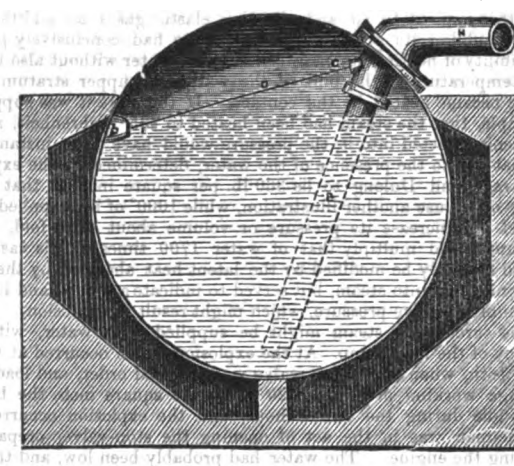


Fig 3

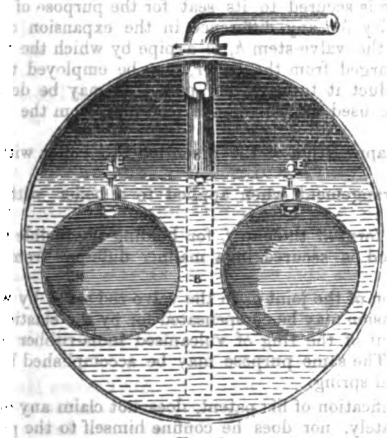
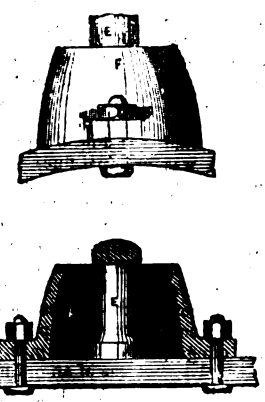


Fig. 4.



Figs. 5 & 6.

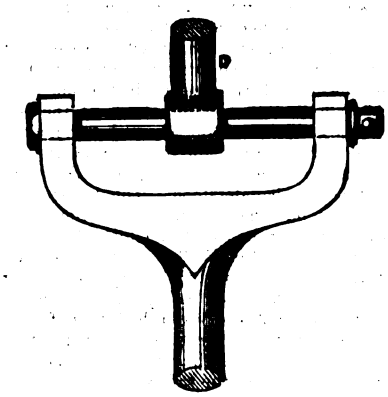


Fig. 7.

majority of explosions took place in boilers of the latter class, and they almost invariably commenced with the collapse of the fire flue.

It was contended that the only objection which could be raised against under-firing, was the danger of incrustation, or deposit upon the boiler bottom of matter held in suspension by the water, but that this rarely, if ever, caused explosions; the utmost injury it occasioned, was causing the boiler plate to be burnt out, and that this effect could not take place without gross neglect. The questions of the possibility of saturating surcharged steam so as to dangerously increase its power, of hydrogen gas being formed in the boiler, and other theories of a similar nature, were avoided, as it was held that each of these, supposing their possibility, must arise from the presence of unduly heated metal within the boiler, which it could not be doubted was the prime cause of nearly all explosions, and that a properly set under-firing boiler could never, except from the most culpable neglect, have any portion of its surface over-heated. It was also suggested, that when it was necessary to stop the engines, instead of closing the damper, it would be safer to leave it open, to close the ash-pit door and to keep the fire-door ajar.

The possibility of the water being repelled from the top of the flue was contested, and it was argued that the water would rather have a tendency to rise up the two sides of the tube. on account of the fire being in immediate contact with the side plates, and thus that the two currents would cause the water rather to heap up over the flue.

Many flue boilers were injured by the flame being allowed to impinge too sharply upon certain parts, and in those spots the plates blistered and were soon burned through; the best remedy for this was to give more flue space, and it would be found that the quantity of steam generated would be increased, whilst the burning of the boiler would be prevented. In many cases of explosion, especially of locomotive boilers, it was evident that the pressure had increased very gradually, and the steam had become surcharged with heat, so that when the explosion occurred all the water was suddenly flashed into steam, as the rails and ground all around were quite dry.

It was doubted whether the fusible metal might not in practice become partially fused at a comparatively low temperature, and allow the valve to open prematurely; and it was urged that it was safer to depend upon the care, skill, and intelligence of the engine-man than upon any self-acting apparatus. Many serious accidents, particularly on railways, had arisen from the attendants being lulled into fancied security by having self-acting points, or other apparatus, which worked well for a time, until something went wrong, and then an accident ensued.

The flues frequently collapsed in consequence of their losing their circular shape by pressure, or from orignally imperfect construction.

The spheroidal theory of M. Boutigny (D'Evreux) was discussed, and a doubt was expressed whether any considerable quantity of water could be brought into the same state as the small quantities upon which his experiments were tried. It was however contended that if a boiler was heated to a very high temperature whilst empty, and the water was then suddenly injected and the aperture closed, an explosion would not occur instantly, because the water would have assumed the spheroidal state: but as soon as the temperature was reduced to the proper degree the steam would be liberated in such a volume and at such a density as to burst the boiler.

In Cornwall, where it was acknowledged that the utmost economy of fuel was practised, the boilers were stated to be nearly all on the internal flue principle, and an accident was scarcely ever known to occur there. It was generally admitted that the apparatus introduced by Mr. Hall would be effective in preventing accidents, but that the main point was to have very ample boiler space, have no self-acting apparatus, and encourage great attention on the part of the engine attendant.

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A new form of boiler was exhibited, and described as having been recently erected, at the works of Messrs. Humphreys, Tennant, and Dykes; the fire-box, of 3 feet diameter, was composed of a series of flanged rings of Low Moor iron, fastened together in such a manner as that the rivets should be surrounded by water, and not be exposed to the action of the fire. The depth of water over the fire-box would be double that over the small iron flues or tubes, which were 3 inches diameter. No double thickness of plate was allowed anywhere. It was intended to supply steam of 70 lb. per inch, and it had been loaded up to 120 lb. per inch. The shell was much stronger than that of one of the Great Western locomotives, and it was anticipated that the steam might be permitted to accumulate without danger.

Several instances were given of explosions of locomotive boilers, presenting many apparent peculiarities, which were, however, all referable to natural causes; in some cases a series of very peculiar circular holes, and in others grooves were found, extending all round the interior of the shell near the rivets. The boilers had failed below the part where they were weakened by the bending over, probably a little too sharply, of the plates.

When it was remembered that the explosion of a boiler under a pressure of 140 lb. per square inch was nearly identical with that of a 10-inch gun, the effects of such an occurrence were not surprising.

In the cotton mills the speeds of the machinery were increased, whilst the boilers became weaker from wear; under such circumstances the occurrence of accidents was scarcely to be wondered at. When steam ceased to act merely by pressure and began to exercise momentum, peculiar effects must be anticipated; but they might all be traced to general rather than to occult causes.

It was stated that nearly if not quite all the instances of explosions, recorded in the 'The Journal of the Franklin Institute,' were from boilers with under-firing, and they were generally considered in the United States as less secure than those with internal fire-flues.

It was stated, relative to the explosion at Sheffield, that it was proved there had been a sufficiency of water over the tube, and yet that one portion of it must have been red-hot: at least such was the appearance exhibited. It was contended that the effect of heaping up the water from the action of the side plates was not nearly so probable as the repulsive action of the top of the flue previously contended for, inasmuch as the latter action was more probable and natural. Also, that if, as has been stated, the water below the flue was unduly cooled at that part the steam would be weak and deficient in quantity. It was reiterated, that if a boiler was of due strength, properly set, and carefully attended to, there was little danger of explosion, until the plates were too much weakened by wear and tear. With all boilers Mr. Hall's apparatus would be a valuable adjunct, and in no case could it be prejudicial.

The double-flue Cornish boiler was mentioned as being preferable to the single firing-flue; the surface exposed was more extensive, and the construction was stronger, the depth of water above the flues was greater, and firing could be alternate. All these were admitted advantages.

It was reiterated that it was not necessary to have recourse to the spheroidal theory, to the decomposition of water, or to any highly scientific arguments, and much less to mysterious or occult causes, for the reasons of explosions. Careful investigation would in general point sufficiently clearly to them when the reasons were fairly sought for.

It was stated that the observed cases of corrosion of the plates of boilers might be referred to galvanic agency, and instances were given of such effects being produced, when the bilge water was taken up by the feed-pumps and injected into the boilers. The sections of metals torn asunder frequently presented proof of an instantaneous generation of explosive power, whether produced by over-heated plates or any other cause; and as the method of discharging the water and the steam from a boiler would appear to be the most effectual mode of preventing danger, it would be only reasonable to employ so simple a precaution as that afforded by Mr. Hall's apparatus.

The opinion as to the little confidence to be placed in self-acting apparatus in general was agreed with; but it was submitted that the self-acting looms, and other machines of that class, and the automatic action of the eccentric upon valve-gear and other similar arrangements, would warrant deviation from the rule, under certain circumstances, among which it was claimed to place that of the spontaneous discharge of the water and steam from the boiler in case of a dangerous degree of pressure being attained.

The experiments of Watt and Southern were alluded to as demonstrating that the latent heat of steam at high temperature was progressively converted into thermometric heat, and the injection of water into surcharged steam would occasion a proportionate increase of pressure. A careful investigation of this subject would probably confirm the alleged result of the experiments undertaken for Mr. E. K. Collins, of New York, which appeared to be, that a saving of nearly 50 per cent. of fuel might be made by the use of surcharged steam.

The decomposition of water on heated plates, although admitted to be an interesting chemical study, was now generally rejected as a practical solution of the question of explosion; and as to the spheroidal theory, any such pressure of steam as must exist within a boiler would practically force the water into absolute contact with the heated surface, and would not permit the globules to be suspended amidst the film of steam at atmospheric pressure, as in an open crucible, or on a plain heated plate. Therefore that theory must almost be abandoned in practice.

The causes of explosions might at first sight appear to be difficult of discovery, but careful investigation generally brought to light evidence of some condition of the boiler under which an accident would be inevitable. The difficulty of arriving at the facts was great after the occurrence of explosions, but there were few cases which did not exhibit undue weakness in some parts of the boiler, or undue steam pressure, without adequate means of affording relief.

In the case of the explosion of the locomotive boiler which had been mentioned, it was well ascertained that the cross stays upon the fire-box top were rather too short, and thus had their bearing inside instead of upon the exterior periphery. Explosions might be generally attributed to equally simple causes, and it was impressed on the meeting to seek for them rather than to raise theories upon some occult causes, the existence of which was very problematical.

Mr. Hall's apparatus might, with advantage, be applied to all boilers, but it would be more useful if, as an invariable adjunct, it could take with it a careful, intelligent fireman, without which no boiler could be considered safe.

At the Monthly Ballot, (March 4th,) The following Candidates were duly elected.—Messrs. M. Blakiston, G. Elliot, J. McLandsborough, and J. P. Ronayne, as Members; R. Johnson, F. Marrable, W. E. Metford, W. W. Pongdestre, T. D. Ridley, and C. Sanderson, as Associates.

March 18.—The paper read was "*On Improvements in Diving Dresses, and other Apparatus for working under water.*" by WILLIAM HEINKE.—Owing to the length to which the two papers on "Mental Calculation," and "Explosions of Steam Boilers," have extended, we are compelled to postpone Mr. Heinke's paper until next month.

ROYAL SCOTTISH SOCIETY OF ARTS.

"*Adaptation of the Micrometer to the Levelling Telescope.*" By E. SANG.—The improvement described in this communication consists in moving the field-bar of the telescope by means of a micrometer screw. The divisions of the level scale are made to correspond with those of the micrometer; so that, when the telescope is slightly out of position, the error can be corrected on the micrometer. In this way the very tedious operation of bringing a delicate level to its zero is avoided. By placing two wires at a proper distance from each other, a means is obtained of correcting directly for the curvature of the earth. But the chief facility is this, that when the utmost degree of precision is wanted, the wire is brought to the divisions on the staff; and the place at which the horizontal line cuts it obtained by computation.

"*Improvements for Heating Bakers' Ovens.*" By ALEXANDER HENDRY.—The mode of heating patented by Mr. Hendry is by a series of pipes through which the heat passes from the the furnace to the flue. These pipes rest upon bars of iron, about fifteen inches from the sole of the oven, and heat the oven thoroughly, the sole as well as the roof, and the heat capable of being easier kept up than by the common method. He stated that there was a great saving in fuel, as in place of good coal or wood, common dross can be used with good effect. Two such ovens when placed side by side can be heated by the same furnace. Mr. Hendry exhibited specimens of bread baked by his new mode of heating, showing that the sole of the oven was sufficiently heated—the bottom of the bread being equally if not better done than the top. He also stated that this method was much more cleanly; there being no fire introduced into the oven and no smoke.

"*Railway Signals.*"—Mr. THOMAS STURROCK stated that, by a very simple contrivance, he has united all the movements of the day-signal with the night-signal; done away with the third colour, or green light, by a combination of red and white only, and by easy application of the lenses superseded the three-lensed lamp now in use, and rendered the signal at once simple and intelligible. He stated that his improvement consists principally in the arrangement of the blades or arms having the lenses attached and fixed lanterns behind the arm; that it is equally applicable to the locomotive engine and the tail-van of a train, thus rendering communication more efficient than at present. He also suggested improvements on the present mode of flag and hand-lamp signalling.—A discussion ensued, in which Mr. Bouch considered Mr. Sturrock's suggestion good for the night-signals, but that it was no improvement on day-signals, which should always be distinguished by their *form* as well as *colour*. Mr. Bouch also strongly advocated the point that railway signals should always give *positive* and not merely negative information. They should leave nothing to be inferred by the engine-driver.

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ENGINEERING WORKS AT BIRKENHEAD.

The important improvements taking place in this town deserve especial notice, as they are tending to make it one of the most complete ports and shipbuilding stations in the world.

The excavations of the Great Float are said to be about commencing, and the building the walls on the Wallasey side of the pool, by which 150 acres of water space will be enclosed, of a depth of about 25 feet. The sanction of Parliament is required before the outer works can be completed, which will enable vessels drawing 20 feet of water to enter the docks every day in the year.

The excavations from the Great Float are to be taken across the marsh to Wallasey, to strengthen the Leasowe embankment.

A large landing-stage is proposed to be erected opposite the South Reserve, as a substitute for a low-water basin.

The graving docks and works between Woodside and Rock Ferry, are rapidly progressing; and the extensive ship-building yard of Mr. Laird makes a conspicuous figure on that part of the river. The workshops have a frontage of 600 feet, and a width of 60 feet. The ground story is to be occupied by the furnaces and smiths' fires, Nasmyth's hammers, and heavy tools. The smoke from the various hearths will be conveyed in tubes to two large chimneys. The top of the building will be level, and applied to the storing of deck planks, for seasoning timber, and for rough joiner's work.

Other workshops, attached to the ends of the large building, will be devoted to finer kinds of joiner's work, draughtsmen, and moulders. A tunnel will be formed to connect the works with the Birkenhead and Chester Railway, and every facility afforded for shipping goods in the river.

The principal graving dock is 450 feet long, with 85-feet gates, and will accommodate a vessel of 10,000 tons. The second graving dock is 400 feet long, by 60 feet; the third 350 feet, by 45 feet; and the fourth, 300 feet by 40 feet. The area occupied by Mr. Laird's docks is about 38,000 yards. Messrs. Clayton and Clover's works are also being completed, with large graving docks and workshops. The Corporation have acted with great liberality in promoting these improvements. They now see that the river unites both towns, and that the improvement of one is to the benefit of the other. The chief merit of originating most of these works is attributed to Mr. Abernethy.

NOTES OF THE MONTH.

A few of the street gas-lamps in Edinburgh have now the name of the street attached to the glass, so that it is distinctly seen during the day, while at night the letters are illuminated by the gas light. This is an improvement expected to be of great advantage to strangers.

The colossal statue of Victory, which forms a part of the group to be erected at Manchester in honour of the late Duke of Wellington, and which has been executed by Mr. Noble, of Bruton-street, has been lately cast at the establishment of Messrs. Robinson and Cottam, at Pimlico, in the presence of a large number of persons connected with the fine arts and with the city of Manchester. The process was completely successful, the metal, which weighed about a ton and a half, running into every ramification of the mould without any flaw whatever.

The City magistrates have condemned Nos. 98, and 99, Cheapside, which have for a long time been in a dangerous state.

The porphyry sarcophagus which King Oscar ordered twelve years ago from the mines of Elfdahe, for the remains of his father, Charles XIV, has just been completed, and will shortly be conveyed to Stockholm.

The long-disputed question as to the disposal of the pictures and other property left by the late J. M. W. Turner, has been decided in the Vice-Chancellor's Court. All the pictures of the testator, touched with his own hand, go to the National Gallery; 20,000*l.* of the property of the testator to be paid to the Royal Academy; and the residue to the next of kin.

Welbeck Abbey, near Worksop, Nottinghamshire, the residence of the Duke of Portland, is shortly to be pulled down, and a new mansion built on a more elevated site in the immediate vicinity of the present house, the situation of which is low and unhealthy. The park round the mansion, which is now about eight miles in circumference, is to be considerably enlarged and improved.

We perceive Mr. George Buckler, the architect and author of some other architectural works, is about to architecturally describe and illustrate, by publication in monthly parts, the Churches of Essex. The ecclesiastical structures of this county are curious specimens of architecture, of great antiquity, and distinguished by peculiar features from those in other parts of the kingdom, Descriptions of these churches have never been published by any architect, except Mr. Hadfield, but which were limited to details of a few well known examples. In the remote parts of the county these edifices are small and unpretending, yet each possesses some distinguishing characteristics both rare and curious. The object of the work is to preserve a record of these ancient buildings, by minutely describing them, and illustrating the description by such plans, general views, and points of detail as may prove of interest to the antiquary, the student, and the general reader. From the specimens we have seen of the work, there can be no doubt but that Mr. Buckler's labour will be a valuable addition to the works we possess on the structure of Parish Churches.

Sir Henry Ellis resigned his responsible post as principal librarian to the British Museum last month. The veteran has served the public for more than thirty years. Mr. Panizzi's appointment as Principal Librarian of the British Museum has received the Queen's assent. The post vacated by Mr. Panizzi, that of head of the Department of Printed Books, will in all probability be filled by Mr. J. Winter Jones, the present Assistant Librarian.

The authorities at the War Office have it in contemplation to form a large camp on Penenden-heath, near Maidstone, during the approaching summer, capable of affording accommodation for several thousand troops.

Captain F. P. Smith has had conferred upon him a life pension of 200*l.* per annum, in consideration of services he had rendered his country, as the first proposer and fitter of the *screw* to the mercantile marine and fleet of Great Britain.

The merchants of Liverpool are making efforts to adorn with first-class sculptures the noble St. George's Hall. Statues of Peel and Stephenson are already placed: and they have now invited twelve of our most eminent sculptors to send in models for a statue of Archdeacon Brooks. The sum named for the work is 1750*l.*

Captain Bell, the American wrecker, is constructing a novel apparatus for raising foundered vessels. It consists of two large timber tanks, shaped like a boot-jack, to receive the ends of a sunken vessel between them. They will be first sunk by filling with water, and attached to the vessel to be raised, after which the water will be exhausted, thus securing an immense lifting power.

The largest locomotive in the world, the "Duke of Brabant," constructed at Seraign, and which attracted so much notice at the Paris Exhibition, is now at work at Charleroy. Its weight is 6000 kilos., and it can move fifty waggons of 10,000 kilos. each—about a million of pounds.

COMPETITIONS.

The Burial Board of Hitchin, Herts, offer 20*l.*, or the superintendence of the work, for designs and estimate for a new Cemetery, to be sent in by April 7th, to Mr. Charles Times, Clerk of the Board.

The Directors of the Manchester, Sheffield and Lincolnshire Railway offer 20*l.* for plans of offices, to be erected near the docks, Great Grimsby; to be sent, before April 14th, to Mr. Edward Ross, Secretary, Manchester.

The exhibition of the drawings for the proposed Notre Dame de la Treille Cathedral, at the Halle au Blé was closed on the 25th ult. There were 41 drawings by architects from England, Holland, Belgium, Switzerland, besides those of France, and the jury, will it is hoped, shortly select the three best designs.

The Committee of the Middlesex Industrial School offer premiums of 150*l.* for the best, 100*l.* for the second, and 75*l.* for the third best plans and estimates, to be sent in by 26th April next, at the Session-house, Clerkenwell.

The Local Board of Health of Garston offer premiums of 70*l.* and 30*l.*, for a system of sewerage for draining the district; specifications, &c., to be sent in on or before 15th of May next, to Mr. J. B. Lloyd, 8, Exchange Alley, Liverpool.

A premium of 20*l.* is offered for best plan and specifications for Dock-offices, Great Grimsby, to be sent in by the 7th of April next, to Adam Smith, Esq., C.E., Great Grimsby.

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NEW CHURCHES.

The widow of the late Dean of Wells is having erected, under the direction of Mr. Teulon, the architect, a new church, at Wells, as a memorial of her late husband. There will be a nave and north aisle, porch, chancel ending in a five-sided apse, and transept. The north end will form the base of the tower, which, with its octangular spire, will be 150 feet high.

The new church at New Brighton is nearly completed; three of the windows in the chancel have been filled with stained glass, by Messrs. Pilkington, of St. Helen's.

All Soul's Church, Vauxhall-road, Liverpool, has just been consecrated. The church is cruciform, 110 feet long, and 42 feet wide, and has a tower and spire at the south-west corner 105 feet high; the tower being 50 feet, and the spire 55 feet. The longer gallery at the end of the nave, and a smaller one at each end of the transept. The walls are rock-faced Woolton stone, lined with brick; the tower and spire of stone throughout. The style is Decorated Gothic.

CHARACTERISTICS OF THE RIVER NILE.

By M. Barthelemy de St. Hilaire, Member of the French Institute.

(Suez, Dec. 15, 1855.

The flow of the waters of the Nile is generally not more than 70 centimetres per second, or 2½ kilometres per hour. During floods it runs a little quicker, but never more than one league per hour, because the slope of its banks is almost as regular as its rise during inundations. Assouon, on the limits of High Egypt and Nubia, is not more than 180 metres above the Mediterranean, and the rising there is almost imperceptible; so much so, that the river never flows with any degree of impetuosity. But the more stable effect of inundations is the slime spread over the whole expanse of the land. It has been found that silica and alumina are contained therein, in the proportion of 42 to 24, while the peroxide of iron forms $\frac{1}{100}$, which imparts to the waters of the Nile its reddish colour, and which they retain during all the time of the rise, while they become again bluish in the ordinary season. Carbonate of soda, magnesia, ulmic acid, and 2·80 of organic matter, complete the composition of the deposit of the waters. A curious question now arises, whence come these animal matters, and why remain constant every year? Some suppose that they arise from the immense *detritus* of animal life redundant in the interior of Africa. This would be, then, a sort of *guano*, which enriches the land of the Pharaohs. On a visit to the Mekkia or Nilometre, we collected a specimen of the slime, which is deposited in all its *purity* on the slope of the reservoir. It is a sort of brown earth *(terre d'Egypte)* of the consistency of clay, and of very fine grain; it is very soft to the touch, and feels almost unctuous. When dry it becomes very hard, which is seen by the numerous deep ravines in the land after the inundation has subsided. The waters of the Nile, thus impregnated, are still very pleasant to drink, and it is recorded that the princesses of the family of the Ptolemies married in Syria, had Nile water conveyed thither for their use, and even some of the sultans much relished it.

The observation of Herodotus, that the shores of the Nile rise constantly, is confirmed even yet, and in some places the layers thus formed may reach a thickness of 10 metres. Interesting are the strata thus formed by the accumulation of many centuries. They are perfectly horizontal, and correspond, moreover, with a mathematical exactitude with the equally parallel lines of the Arabian and Lybian mountains, distant about two or three leagues from the Nile. The irrigation and canalisation of Egypt are, therefore, its most important objects, to which, from Sesostris down to Mehemet Ali, all rulers have paid more or less attention. The latter completed the canal of Mahmoudieh (20 leagues long), with a more than Pharaohic daring, in a few months. With the same zeal he constructed the *barrage* of the Nile at Saidieh, and the present viceroy has projected another at Silsileh in Upper Egypt. Myriads of rivulets have been artificially constructed, while man has shut up five of the seven mouths of the Nile. I ascribe the eternal slavery of the Egyptians to the physical condition of the country, because with any degree of civil liberty these huge and innumerable canals, lakes, and bars, could never have been kept in adequate order and condition.

RAILWAY AND CANAL BILLS.

The report of the Board of Trade to the House of Commons on the railway and canal bills of the present session, shows that the number of bills for railways in Great Britain deposited this session amounts to 91, of which 65 authorise new works, including 39 by new and 26 by existing companies. The length of line proposed to be executed by the new companies is in England 146 miles, in Scotland 262, and in Ireland 65 miles; and the length of line proposed to be executed by old companies in England 174 miles, in Scotland 11, and in Ireland 18, making a grand extent of 473 miles by new, and 203 miles by existing companies. The total length of new lines is, therefore, 676 miles, and there are also 42 miles of deviation, and 14 projects for enlarging stations, &c. The Board of Trade intimates that the recommendation of the Select Committee on Railway and Canal Bills in 1853, that no new scheme should be allowed to proceed without effectual security being given for its actual and immediate completion, will to some extent be defeated, if the time originally allowed for the completion of the works be extended by subsequent acts. There are five intra-metropolitan lines included in the above list, and the recommendation of the Royal Commission of 1846 is pointedly referred to by the Board of Trade. This was to the effect that if at any time railways should be admitted within the metropolitan limits it should be done in conformity with some uniform plan, authorised by government and sanctioned by parliament; and that under no circumstances should the throroughfares of the metropolis and the property and comfort of its inhabitants be surrendered to separate and independent schemes. The scheme for improving the Thames is particularly referred to in this respect. The bills which this part of the report would seem to affect are—the Metropolitan Railway Bill, the Provincial Railways (Joint Station) Bill, the Thames Embankment and Railway Bill, the Westminster Terminus Railway Bill, and the Westminster Terminus (West London Extension) Bill.

NEW PATENTS.

PROVISIONAL PROTECTIONS GRANTED UNDER THE PATENT LAW AMENDMENT ACT.

Dated December 1, 1855.

2711. Sir C. E. Grey, Rue du Mont Thabor, Paris—The use of a new vegetable material for raising the nap and dressing woollen cloths and webs and tissues

Dated December 5.

2735. T. M. Fell, Frederick-street, Gray's-inn-road—An improved ships' cooking and distilling apparatus, and improvements for the production of fresh water from sea or salt water

Dated January 8, 1856.

20. H. Brambach, Cologne, Prussia—Converting dry pitch and other resinous substances, also coal tar and other tars, into neutral essential oils
21. E. V. Neale, Russell-place, Fitzroy-square—Improvements in labels

Dated January 8.

57. C. L. Pariset, Paris—An improved paste for manufacturing paper, pasteboard, and other similar products
59. C. Pietroni, London-wall—Improvements in printing on cloth and other fabrics. (Communication from G. Bossi, Vienna)

Dated January 11.

87. W. Smith, Little Woolstone, Bucks—Improvements in ploughs and other cultivating implements

Dated January 16.

111. T. Dunn, Windsor-bridge Ironworks, Pendleton, Lancaster—Improvements in boilers and apparatus for heating water and generating steam

Dated January 17.

126. S. R. Carrington, Stockport—Improvements in the manufacture of hats, and i machinery or apparatus connected therewith

Dated January 21.

157. J. C. Hadden, Cannon-row, Westminster—Improvements in omnibuses and other similar carriages

Dated January 25.

197. F. Chauchard, Paris—Improvements in the manufacture of paper and pasteboard from vegetable and wood substances
203. J. Beads, Pendleton, near Manchester—Improvements in machinery or apparatus for spinning cotton, wool, or other fibrous substances where self-acting mules are used
205. G. Brown, Swinton, near Rotherham—An improvement in the manufacture of cast steel

Dated February 1.

271. A. Macpherson, Brussels—Improvements in obtaining and applying motive power. (Communication)
273. E. Schischkar, Halifax—Improvements in dyeing and colouring wools, hairs, silks, yarns, and textile fabrics made of the same materials either wholly or partially
275. G. Holcroft, J. Smith, and T. Holcroft, Manchester—Improvements in machinery for preparing, spinning, and doubling cotton and other fibrous materials
279. A. Lamb and J. Ronalds, Southampton—An improvement in the construction of iron ships, boats, and other similar structures
281. H. Bostwick and J. Bury, Manchester—Improvements in cocks, taps, or valves
283. J. T. Chance, Birmingham—Improvements in furnaces used for flattening glass
285. A. E. Dannequin, Rue de l'Echiquier, Paris—Improvements in caoutchouc or any other waterproof garments
287. B. F. Miller, New York, U. S.—Improvements in ventilators for chimneys and other purposes

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Dated February 2.

229. J. T. Ward, Swansea—A new or improved omnibus
232. W. J. Curtis, Sebbon-street, Islington—Improvements in machinery for excavating land for the constructing tunnels

Dated February 4.

296. A. Tolhausen, Duke-street, Adelphi—Improvements in machinery for picking, carding, and combing fibrous substances. (Communication from R. Kitson, Lowell, U. S.)
296. R. C. Pauling, Great George-street, Westminster—Expelling water from vessels and keeping them from sinking, raising sunken vessels, keeping water out of cofferdams, caissons, foundations, or vessels, or works that are below water, and propelling vessels on and through water
297. R. Bodmer, Thavies-inn, Holborn—An improved lubricating oil. (Communication)
299. E. S. Robinson, Bristol—Improvements in machinery for lithographic and zincographic printing
300. C. H. Hudson, Highbury-cottages, Holloway-road—A retiring door or lid for boxes cabinets, closets, rooms, carriages, and for all places or receptacles where or in which doors or lids are at present in use or may be used
301. E. Clark, Great George-street, Westminster—An improvement in the apparatus for suspending insulated electric telegraph wires
302. J. Thomson, Newton-le-Willows, Lancaster—Improvements in centrifugal apparatus to be used in the separation of liquids from granular and crystalline matters
305. W. A. Turner, Wood-street, Cheapside—An improved preparation or mixture to be used in the manufacture of compounds of india-rubber or caoutchouc

Dated February 5.

307. G. C. Thomas, Washington, U.S.—An improved method of hardening and tempering steel. (Communication)
309. T. Hinchliffe, Mill-bridge, Liversedge, York—Improvements in machinery or apparatus for drawing and spinning wool or other fibrous substances, or wool mixed with other fibrous substances
311. T. Bergner, Philadelphia, U. S.—Embossing veneers, so as to represent carvings in wood. (Communication from I. Amies, Philadelphia)
312. J. Howard, Bedford—Improved apparatus for making moulds for castings
314. A. McDougall, Manchester—Improvements in treating bones, other animal matters, and other substances containing phosphates, for the purpose of obtaining manure and other products
315. A. A. de Reginald Hely, Oxford-street—Improvements applicable in the burning of gas
317. H. Squire, Ludgate-hill—An improved seal or fastening for envelopes, deeds, and documents

Dated February 6.

319. J. Thomas, Finsbury-square—Improvements in the manufacture of soap from the greasy matters obtained from the refuse water, wash, or suds, used in woollen or other manufactures or processes. (Communication)
321. J. Fletcher and W. Fletcher, Salford—Improvements in the construction of weighing cranes, and other similar elevating machines
323. H. A. Jowett, Kentish-town—Improvements in railway breaks and carriages, and in signals connected therewith
325. T. F. Tyerman, Weymouth-street—Improvements in apparatus to be applied to omnibuses and other carriages for receiving wet umbrellas
327. J. E. Duyck, Wandsworth—Improvements in the manufacture of oil-cake
329. J. Meacock, Snow-hill—An improved means of fixing diaphragms in gas meters

Dated February 7.

331. T. Bergner, Philadelphia, U. S.—A new mode of preparing or facing surfaces of engraved or etched plates of metal, or other substance, so that they may be readily printed from by a press without wiping. (Communication from S. W. Lowe, Philadelphia)
332. W. Kenworthy, Blackburn—Improvements in self-acting mules
333. R. A. Brooman, Fleet-street—A method of obtaining alcohol from the fruit or pod of the carob tree. (Communication from J. Minghelli)

Dated February 8.

335. J. Woodman, Manchester—An improved telegraph insulator
336. T. F. Trocard, Bordeaux, France—An improved coffee-pot
338. H. A. Jowett, Kentish-town—Improvements in rails used for the construction of the permanent way of railways, and in the means of laying down and fixing them in conjunction with the present rails in use
339. S. Robertson and J. Howden, Glasgow—Improvements in machinery or apparatus for driving piles
340. C. Walker, Glasgow—Improvements in safety-valves and in apparatus for cleansing or purifying water in steam-boilers
341. J. B. Booth and J. Beckett, Preston—Improvements in machinery for preparing and spinning cotton, wool, and other fibrous materials

Dated February 9.

342. C. Swan and G. F. Swan, High-street, Southwark—Improved colouring matter for writing, staining, or dyeing, which is also applicable to the production of a copying fluid. (Communication)
343. J. Elce and S. F. Cottam, Manchester—Improved mode of lubricating the spindles of machinery used in preparing and spinning cotton and other fibrous materials revolving in a lifting rail
344. G. Wailes, Palace-row, New-road—Improvements in the construction of valves for regulating the passage of gas and other fluids
346. J. Rowlings, George and Catherine-wheel-yard, Bishopsgate-street—Improvements in envelope or stationery cases
347. R. Martin, Oxford—Improvements in cricket-bats
348. T. Burton, Lincoln—An internal boiler cleaner or mud stirrer for the effectual cleaning of steam-boilers from muddy deposits and all kinds of sediments
349. T. Cavé, Paris—Improvements in oil-lamps, which he calls the "Continual Lamp"
350. L. Schwartzkopff, Berlin—Improvements in apparatus for raising mud and soil from the bottoms of rivers and other waters
351. W. A. Bullard, Dedham, Massachusetts, U. S.—Improvement in instruments for fastening doors. (Partly a communication)

Dated February 11.

352. C. Muratori, Paris—Improvements in the waterproofing of hangings or ornamenting stuffs
353. W. H. Harfield, Fenchurch-street—Improvements in the manufacture of metallic screw nuts. (Communication)
354. W. H. Zahn, New York, U. S., and J. H. G. Wells, Ebenezer-place, Neckinger-road, Bermondsey—Improvements in windmills or wind engines
356. T. Steven, Milton Foundry, Glasgow—Improvements in the construction of open and close stoves, which improvements are applicable in part to kitchen ranges and boiler fire-places

Dated February 12.

356. H. Bessemer, Queen-street-place, New Cannon-street—Improvements in the manufacture of malleable or bar iron and steel
357. J. M. Guidicelli, Rue Bonaparte, Paris—Improvements in the transformation of movement in steam engines and other machinery
358. G. T. Bousfield, Sussex-place, Loughborough-road—An improvement in treating fats and oils. (Communication)
359. R. A. Brooman, Fleet-street—Improvements in the manufacture of cast steel. (Communication)
360. F. P. Jablonowski, Brussels—A new process of chromo-lithographic painting on glass, porcelain, clays, lava, and other materials susceptible of vitrifaction, and on all metals and metallic compounds capable of receiving an enamelled surface

Dated February 13.

361. F. Steiner, Accrington, Lancaster—Improvements in machinery to be used in drying fabrics
362. P. I. David, Paris—Improvements in the method of bleaching
364. L. Vignat, Place des Victoires, Paris—A regulator-compensator for the weaving of ribbons and cloths
365. W. F. C. Moutrie, King-street, Holborn—Improvement in the damper action of pianofortes
366. S. Fox, Stocks-bridge, Peniston, York—Improvements in springs for railway and other carriages
367. R. Knight, Foster-lane—Improvements in medical chests
368. W. Gilchrist, Kirkintilloch, Dumbarton—Improvements in ornamental weaving
369. W. E. Newton, Chancery-lane—Improvements in the manufacture of zinc. (Communication)
370. W. E. Newton, Chancery-lane—Improvements in the construction of fire-arms. (Communication)
371. A. V. Newton, Chancery-lane—Improvements in springs applicable to railroad carriages and to other uses. (Communication)
372. H. P. Mitchell, W. Mitchell, and J. Clarkson, Silsden, near Keighley, York—Improvements in sewing machines
373. J. Barber, Manchester—Improvements in steam-engines
374. G. L. Keller, Paris—A new kind or system of carpet or travelling bag
375. W. Parsons, Hugh-street, Pimlico—Improvements in spindles for locks and latche

Dated February 14.

376. T. P. Capp, Gracechurch-street—An improved lamp
378. H. R. Ramsbotham and W. Brown, Bradford, York—Improvements in combing wool, alpaca, cotton, and other fibrous substances
379. S. R. Parkhurst, New York, U. S.—Improvements in sails and rigging for vessels
380. W. McFarlane, Glasgow—Improvements in building and structural works, and fittings in metal
381. J. Emsley, Bolton-road, Bradford—Improvements in tube-spinning frames employed in spinning worsted-yarn and other fibrous substances
382. G. P. Cooper, Sutherland-square, Walworth—An improved shirt collar
383. J. Taylor, Spring-grove, Hounslow—Improvement in constructing and facing walls
384. W. H. Bartholomew, Brunswick-terrace, Leeds—Improvements in propelling vessels when screws or submerged propellers are used
385. E. Morewood and G. Rogers, Enfield—Improvements in drying and coating iron and copper
386. W. W. Hewitson, Headingley, near Leeds—Improvement in casting the bearings or brasses of machinery
387. T. E. Blackwell, Clifton, near Bristol—Improvements in condensing steam, and in cooling and heating fluids
388. C. Cowper, Southampton-buildings—Improvements in impregnating wood with preservative and colouring materials, and in apparatus for that purpose. (Communication from the late H. Boucherie, Bordeaux, France)
389. G. Gulliver, and J. Goldthorpe, Barnsley York—An improved signal bell
390. E. Deiss, Paris—A method or methods of, and apparatus for extracting oils, fats, greases, and resins from bones, raw wool, seeds, and other substances containing the same, and recovering a certain agent employed in the process

Dated February 15.

391. E. Oldfield, Adelphi ironworks, Salford—Improvements in self-acting mules for spinning
392. A. Tolhausen, Duke-street, Adelphi—A machine for cutting articles of polygonal figure in wood or other material. (Communication from A. Stoeckel, New York)
393. E. Leach, J. Leach, and E. Leach, jun., Rochdale—Improvements in machinery or apparatus for preparing, spinning, and drying yarns, and manufacturing the same into cloth
394. J. Hogg, jun., Nicolson-street, Edinburgh—Improvements in the manufacture of envelopes and certain other combinations and applications of paper and gum, denominated "Letter Checks," for containing and securing written, printed, or other communications
395. E. Dobell, Hastings—Improvements in lamp-glasses or conductors of light
396. E. Elliot, C. Leach, and J. Ratcliffe, Rochdale—Improvements in machinery for spinning wool and other fibrous substances
397. J. H. Johnson, Lincoln's-inn-fields—Improvements in fountain pens. (Communication from N. A. Prince, New York)
398. W. E. Newton, Chancery-lane—Improved machinery for making boots and shoes. (Communication)

Dated February 16.

399. A. P. Rochette, Brighouse, near Huddersfield—Improvements in treating soapsuds to obtain products therefrom
400. F. D. Grant, Newgate-street—A method of rendering printing inks and wax odoriferous
401. F. Parker, the Halve, Trowbridge, Wilts—Improved apparatus for affording exercise to the human body
402. G. Harrison, Little Goodwin-street, Hull—Improvements in axles for railway carriages
403. H. J. Hyams, Stanhope-street, Hampstead-road—Improvements in the construction of gas-meters

Dated February 18.

404. W. W. Sleigh, London—Producing motive-power, which he entitles "the Hydrostatic Motive-power Engine"
405. A. V. Newton, Chancery-lane—Improvements in the construction of steam-engines for the purpose of converting the reciprocating motion into a rotary motion, and for operating the slide-valves. (Communication)
406. J. S. Thomson, and A. Barclay, Kilmarnock—Improvements in printing and embossing textile fabrics and other surfaces, and in the production of apparatus to be employed therein
407. H. Hodgkinson, Donegall-street-place, Belfast—Improved machinery or apparatus for bleaching cotton, linen, and other woven or textile fabrics
408. M. Jones, W. B. Rowe, and W. Perrins, Broad-street, Worcester—An improvement in ranges
409. M. Defries, Houndsditch—Improvement in supplying oil to the burners of lamps
410. W. Hale, Swan-walk, Chelsea—Improvements in propelling boats or other floating bodies

Dated February 19.

411. W. H. Walenn, Chancery-lane—Improvements in saw-teeth. (Communication from N. Barlow, Newark, U. S.)
412. H. Gerbaut, Mulhouse, France—Improvements in the manufacture of vinegar
413. S. E. Sichel, Bradford, York—Improvements in apparatus for weaving ribbed cloth and bands of chenielle. (Communication)
414. F. A. S. Witter, Manchester—An improved stove. (Communication)

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415. W. H. Bowers, Singleton-street South, East-road—Improvements in the construction of railways
416. S. F. Cox, Bristol—Improvements in the manufacture of leather, and in machinery for that purpose
417 J. Gedge, Wellington-street South—Improvements in curry-combs. (Communication from F. B. Loubatieres, Agen, France)
418. J. Gedge, Wellington-street, South—Improvements in pumps. (Communication from A. Adrien, Castres, France)
419. C. S. Jackson, Cannon-street—Improvement in preserving and disinfecting timber and other substances
420. W. G. Merrett, Leadenhall-street—Improvement in trousers and drawers
421. W. Savory, and H. Arkell, Gloucester—Improvements in apparatus for the passage of water and other fluids
422. R. Waygood, Newington-causeway—Improved portable laundry, or combined boiling, washing, mangling, and drying and ironing apparatus

Dated February 20.

424. R. Laming, Carlton-villas, Maida-vale, Paddington—Improvements in purifying gas, in preparing materials useful for purifying gas, and in apparatus to be used in purifying gas and in disinfecting gas liquors or washings
425. T. Smith and J. Gill, Hebdenbridge, York—Improvements in the mode or method of casting horizontal shafting
426. W. Muir, Britannia Works, Manchester—Improvements in slide-lathes
427. J. Knowles, Eagley-bank, near Bolton-le-Moors—Improvements in the construction of metalic pistons
428. W. Lynn, H. M. Dockyard, Portsmouth—Improvements in the construction and mode of applying screws for propelling vessels
429. J. Gedge, Wellington-street South—Improvements in syphons. (Communication from B. A. S. Duvignau, France)
430. R. A. Brooman, Fleet-street—Improvements in working railway switches and crossings, and certain indicating apparatus for preventing accidents on railways (Communication from A. Dumas, Paris)
431. J. Freer, Rothly, Leicester—Improvements in machines for planting grain and seed, and an improved seed feeder and meter for planting machines
432. W. Clibran and J. Clibran, Manchester—Improvements in and applicable to apparatus or mechanism for measuring and regulating the flow of gas, and in the mode of constructing parts thereof
433. J. H. Johnson, Lincoln's-inn-fields—Improvements in steam-engines. (Communication from N. Duvoir, Liancourt, France)
434. J. H. Johnson, Lincoln's-inn-fields—Improvements in machinery or apparatus for lubricating bearings, parts of which improvements are applicable to the raising or elevating of liquids. (Communication from E. Bourdon, Paris)
435. J. Clark and J. Austin, Moorgate-street—Improvements in apparatus for stoppering and closing bottles, jars, and other similar vessels
437. H. Sherwood, Esholt, near Leeds—Improved means of treating the "spun waste" of wool, cotton, silk, flax, hemp, and other fibrous substances so as to render it suitable for reworking
438. J. Barsham, Kingston-upon-Thames—Improvements in the manufacture of cases or packings for bottles and jars
439. W. O. Johnston, Broom-hill Colliery, Acklington, Northumberland, and J. Dixon, High Bridge Works, Newcastle-upon-Tyne—Improvements in cutting and working coal

Dated February 21.

440. I. Moll, Cologne, Prussia—The treatment of sulphate of alumine of commerce, and its formation of compounds useful for the disinfecting of organic substances in a state of putrefaction, as well as for other purposes
441. L. A. Joyeux, Marseilles—Improvements in obtaining motive power
442. J. H. M. Maissiat, Paris—Improvements in projectiles for fire-arms
443. W. Dawson, Otley, York—Improvements in machinery or apparatus for cutting paper or other materials
444. T. Bennett and W. P. Dugdale, Farnworth, Lancaster—Improvements in flyers used in spinning machinery
445. J. Gedge, Wellington-street South—Improvements in looms—(Communication from J. Desage, Rheims, France)
446. F. Enthoven, Moorgate-street—Improved cover for gunpowder and other canisters and vessels. (Communication from C. Enthoven, the Hague)
448. W. Clarke, Nottingham—Improvements in the manufacture of warp fabrics
449. T. T. Chatwin, and J. F. Chatwin, Birmingham—Improvements in buttons
450. J. Diment, Bristol—Improvements in the manufacture of cements
451. C. F. Dennet, Lansdowne-villas, Kensington-park, and G. Pays, Oxford-street—Improvements in cartouche and percussion cap pouches

Dated February 22.

452. J. S. C. Heywood, Battle-bridge, and G. Lloyd, Great Guildford-street, Southwark—Improvements in condensing vapours in distillatory operations, the manufacture of varnishes, melting and distilling of fats and other manufacturing or chemical operations, and obtaining useful products therefrom
453. F. W. Mowbray, Saltaire, near Bradford—Improvements in machinery or apparatus employed in spinning and doubling
454. J. K. Field, Lambeth, and C. Humfrey, Terrace, Camberwell—Improvements in the manufacture of paraffine candles
455. W. V. Wallace, Great Portland-street, and B. L. Sowell, Harrow-road—Improvements in treating tobacco in order to manufacture cigars and other articles for smoking, together with the manufacture of cigars and cheroots from the tobacco so treated. (Communication)
456. J. Griffiths, Wolverhampton—A new or improved break for colliery and other steam engines
457. L. Bower, Birmingham—New or improved machinery for the manufacture of screws
459. G. Toucas, Rue de l'Echiquier, Paris—A new metallic alloy

Dated February 23.

460. E. Schischkar, Halifax—Improvements in cleansing silk, hair, wool, yarn, and textile fabrics
463. D. Jones, Green-hill Villa, Ragland, Monmouth—Improvements in obtaining and applying motive power
464. G. H. Spencer, Heathersage, near Sheffield—Improvements in the manufacture of card surfaces employed in carding cotton and wool
465. S. Walsh and J. H. Brierly, Stannary Works, Halifax, and Noble-street, Cheapside—Colouring and graining skins of leather on one side, and japanning them on the other side
466. T. G. Messenger, Loughboro'—Improvements in boilers
467. R. B. Jones, Limerick—Improvements in cooking apparatus
468. J. Scudamore, Mitcheldean, Gloucester—Improvement in domestic stoves or grates
469. J. Warburton, Addingham, Otley, York—Improvements in machinery for combing wool, cotton, and other fibres
470. H. Loveridge, Wolverhampton—Improvement in feet, hip, and slipper baths, also in bases for shower-baths, and basins for washing and other purposes
471. W. Sangster, Cheapside—Improvement in the manufacture of umbrellas and parasols
472. S. R. Samuels, Nottingham—Improvements in weaving fabrics
473. C. Brook, Meltham-mills, near Huddersfield, and J. Hirst, Willshaw, near Huddersfield—Improvement in finishing yarns of wool or hair, and in the finishing of woven fabrics or piece goods

Dated February 25.

474. L. Normanby, Judd-street, Brunswick-square—Improvements in the mode of constructing and fixing the rail of railways. (Communication from L. D'Aubréville, Rue de l'Echiquier, Paris)
476. F. Kersey, Laurie-terrace, St. George's-road, Southwark—An improvement in the manufacture of drain pipes
478. R. Hawthorn and W. Hawthorn, Newcastle-upon-Tyne—An improved arrangement of steam pump
480. C. F. Claus, Latchford, Chester—Improvements in metal shipbuilding, applicable also to steam boilers, bridges, and other structures in which metal plates are used
482. C. D. A. J. Planque, Pont St. Maxence, France—Improvements in the manufacture of fecula
484. E. Slaughter, Avonside Ironworks, Bristol—Improvements in the fire-boxes of locomotive and other steam boilers

Dated February 26.

486. J. P. Joule, Manchester—Improvements in steam-engines
490. J. Steedman, Albany-street, Middlesex—An improvement in pianofortes
492. P. Schafer and F. Schafer, Brewer-street, Middlesex—An improved apparatus for damping gummed stamps, tickets, labels, and envelopes
494. R. A. Brooman, Fleet-street—A composition or compositions to be used as a substitute for hops in brewing. (Communication from A. Boehler and P. F. Quantin)
496. I. Reckitt, G. Reckitt, and F. Reckitt, Kingston-upon-Hull—Improvements in the manufacture of starch, British gum, and size

Dated February 27.

498. G. M. Legrand, Rue de Bretagne, Paris—Improvements in graining and chequering skins and woven tissues
500. J. H. Johnson, Lincoln's-inn-fields—Improvements in the treatment of hard india-rubber for the purpose of rendering the same applicable to the manufacture of pens, tubes, springs, and other similar articles. (Communication from C. V. Steinlen, Paris)
502. W. Exall, Reading—Improvements in the manufacture and arrangement of sawing-machinery
504. A. Inglis, New River Head, Clerkenwell—An improvement in the manufacture of flexible bottles or cases for containing colours and other fluids and semi-fluids

Dated February 28.

506. F. P. Walker, Manchester—Improvements in machinery for cutting hay, straw, and other vegetable substances
508. J. Smith, Derby—Improvements in water-gauges for steam boilers, which improvements are also applicable to cocks used for steam and other purposes
510. P. D. Margesson, Woolwich—Improvements in the manufacture of iron from iron ores
512. J. Fowler, jun., Havering, near Romford, and D. Greig, Barkingside, Essex—Improvements in ploughing and tilling land
514. C. A. de Fonbonne, Paris—Improved apparatus for the manufacture of coke and for blasting, also for the production and extraction of illuminating and combustible gas, as well as ammoniacal and bituminous matters, part of such apparatus being applicable to the consumption of smoke
516. R. A. Brooman, Fleet-street—Improvements in treating bituminous shale, bogbead, mineral, and other like schistous bodies, in order to obtain various commercial products therefrom. (Communication from P. G. Barry)

Dated February 29.

518. J. Brierley, Blackburn—Improvements in machinery or apparatus for twisting and doubling yarns for mule-banding and similar purposes
520. J. Graham, Aughton, Lancaster—Improved machinery for cleaning and dressing rice and other grain
522. F. Connor, Belfast—Improvements in looms for weaving
524. W. A. Turner, Wood-street, Cheapside—Improvements in the manufacture of elastic tubing

Dated March 1.

526. W. Clark, Upper-terrace, Islington—Improvement in cutting or shaping trousers
528. J. Reading, Birmingham—New or improved fastenings for attaching watch-keys, seals, watches, lockets, articles of jewellery, and ornamental articles of dress in general to chains, and for securing the catches of brooches
530 J. H. Johnson, Lincoln's-inn-fields—Improvements in looms for weaving. (Communication from G. Bornèque, Bavillers, France)
532. L. Uytborck, Montagne-de-la-Cour, Brussels—An improvement in locomotive and other tubular boilers, in which steam is generated
534. F. Kaselowsky, Bielfield, Prussia—Improvements in winding yarns and thread or flax and hemp in spinning and twisting machines
536. W. Chapman and J. H. Teager, Ipswich—Improvements in apparatus for cooking animal and vegetable substances, and for heating steam closets

Dated March 3.

538. R. Maynard, Whittlesford, Cambridge—Improvements in machinery for cutting and separating agricultural produce
540. J. Wallace, jun., Glasgow—Improvements in bleaching, washing, cleansing, and drying textile fabrics and materials
542. J. Aspinall, Limehouse—Improvements in machinery for curing sugar, or extracting moisture therefrom, applicable to separating liquids from solids
544. J. Venables, Burslem, Stafford—Improvements in ornamenting articles made of clay and other similar plastic materials

Dated March 4.

546. E. Poitiers, Malden-terrace, Haverstock-hill—The application of a new material or materials for the manufacture of brushes and for other purposes, and for improvements in the manufacture of street scavengers' and similar brooms or brushes
548. R. A. Brooman, Fleet-street—An improved fabric suitable for ladies' garments. (Communication from M. Constant, Paris)
552. J. Platt, Oldham, Lancaster—Improvements in machinery for spinning, doubling, and winding cotton and other fibrous materials. (Communication)

Dated March 5.

554. S. Clegg and J. Kay, Padiham, near Burnley—Improvements in machinery or apparatus for warping yarns
556. W. Billington, Great George-street, Westminster—An improved method of treating wooden railway sleepers
558. C. Morgan, Cwm Aman, near Llanelly, Carmarthen, and C. R. Vickerman, Kilgetty, near Saundersfoot, Pembroke—An improved preparation of fuel, and the application of the same to steam boiler purposes

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PATENTS APPLIED FOR WITH COMPLETE SPECIFICATION.

423. W. A. Vérel, Macduff, Banff—Improvements in grinding or pulverising hoofs and horns, and in using them alone or mixed with pulverised bones for manure—February 20, 1856
481. L. Arnier, Marseilles, France—Improvements in condensing hot air and obtaining motive power therefrom—February 25, 1856

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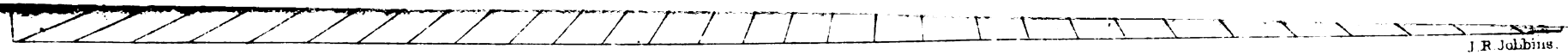

J.R Jobbins.

THE ANCIENT DINING HALL

AS RESTORED AT THORNTON HALL BUCKS, THE SEAT OF THE HON^{BLE} RICH^{D} CAVENDISH.

JOHN TARRING, ARCH^{T}

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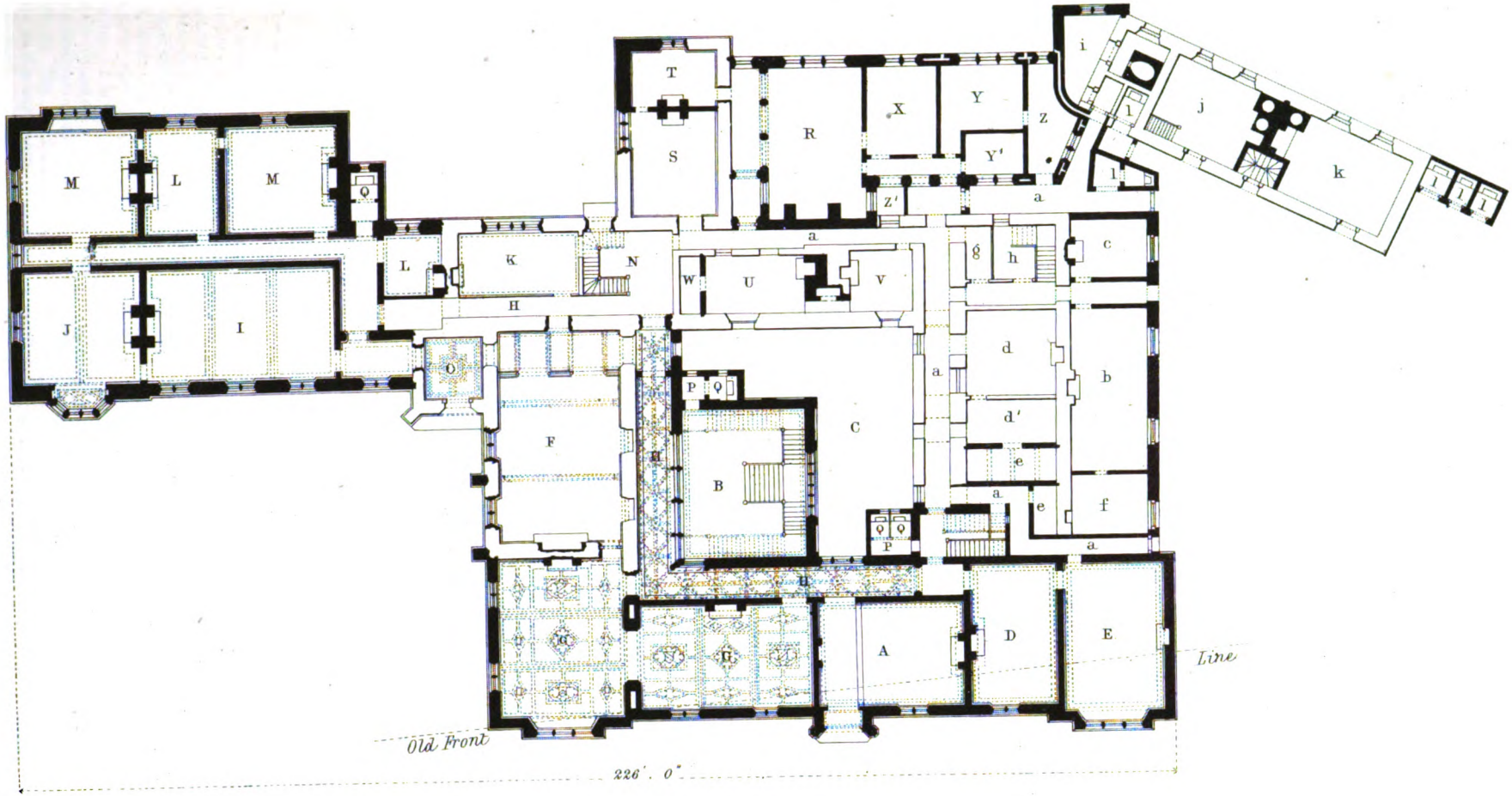
GROUND PLAN OF THORNTON HALL BUCKS, THE SEAT OF THE HON.BLE RICH.D CAVENDISH.

JOHN TARRING, ARCH.T



NB. The Wall of the new Parts are filled in black.

10 5 0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 FEET

J.R.Jobbins.

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THORNTON HALL, BUCKS.

J. Tarring, *Architect.*

(*With Engravings, Plates* XII. *and* XIII.)

In No. 261, Vol, XVIII. of our *Journal*, appeared an account of the restorations and additions that have been made to this interesting hall, in which reference was made to the ancient dining-hall. By our present engravings, Plate XII., which exhibits an interior view of that apartment, as proposed to be restored; and Plate XIII., an entire ground-plan of the building, we are enabled to show the portions that have been added and altered.

To the dining-hall an entire new roof has been constructed over the old oak one, so that the latter forms the ceiling only; by this arrangement it is preserved from further decay, and the warmth of the hall greatly promoted.

During the progress of the alterations, we learn that curiosity induced the architect to examine what had been considered a wall, at the west end of the dining-hall, and on the removal of some of the plaster, it was found that the ancient oak screen was concealed by it. The screen had received much damage in the operation of being put out of sight, but there remaining the most important parts, and the whole of the tracery-heads of the panels, a complete restoration has been skilfully effected.

In the ground-plan, those walls filled-in black show the extent of the new buildings; the wing at the left is an entire addition. The buildings had, however, evidently extended in that direction, as remains of the foundations were discovered in forming those of the new buildings. The line of the old part, forming the principal front, is indicated by the dotted lines, by which it will be seen that this part of the hall, as it existed before the recent alterations, was not uniform with the other old parts. It is difficult to account for such a deviation from the usual practice, of keeping the several parts at right angles with each other; there was nothing in the site to interpose any obstacle to such an arrangement. It may be remarked, however, that the architecture of this part was of a much later date than that of the dining-hall; it is therefore probable that it had been rebuilt, and that the irregularity in the plan was made at that time.

Reference to Plate XIII.

A. Entrance Hall.
B. Principal Staircase.
C. Open Court.
D. Morning Room.
E. Private Dining Room.
F. Old Dining Hall (restored).
G. Drawing Rooms.
H, H. Corridor and Passage.
I. Library.
J. Billiard Room.
K. Mr. Cavendish's Room.
L, L. Dressing Rooms.
M, M. Bed Rooms.
N. Staircase.
O. Tower.
P, P. Lobbies.
Q, Q. Water Closets.
R. Kitchen.
S. Housekeeper's Room.
T. Cook's Room.
U. Housemaid's Room.
V. Still Room.
W. Strong Closet.
X. Scullery.
Y. Raw-meat Larder.
Y'. Cold-meat Larder.
Z. Game Larder.
Z'. Boiler Room.

a, a. Passages.
b. Servants' Hall.
c. Butler's Room.
d. Under Butler's Pantry.
d'. Under Butler's Sleeping Room.
e. Strong Closet.
e'. Closet.
f. Brushing Room.
g, h. Coals and Shoe Rooms.
i. Bakehouse.
j. Wash-house.
k. Brewhouse.
l, l. Water Closets.

The church of Bilton, erected from designs by Mr. Scott, was lately opened. The general style of architecture is Early English. In the clerestory the architect has introduced a double window of a later period, instead of the single lancets of the nave and chancel. The roof of the chancel is of timber, the ribs springing from the corbels, and intersecting each other somewhat like a groined ceiling. The roof of the nave is of open timberwork. The walls of the interior are of limestone. The pulpit is of an octagonal form, and is constructed of white limestone. The chancel windows will be of stained glass; the windows at the eastern end only are now filled, and were executed by Mr. J. C. Crace, of London. The subjects of the medallions in the east window are incidents in the life of Christ. The total length of the church is about 77 feet; the chancel is 34 feet long and 20 feet wide.

THE COMPETITION SYSTEM AND ITS PROSPECTS.

We look forward to the approaching competition for the Free Library and Museum, at Liverpool, with earnest and anxious, yet trustful hope, as being likely, quite independently of its immediate results, to lead to a reform of the present highly objectionable, not to say corrupt, system of architectural competition. Room there most assuredly is for improvement, because hitherto competitors have had no sort of pledge for fair-dealing. All is conducted with the most jealous, consequently suspicious secrecy; nothing permitted to transpire that can possibly be kept concealed. The final decision must, of unavoidable necessity, be known; but it is not always that we are permitted to know what the chosen design is until it is executed, when it perhaps turns out to be so unsatisfactory that, supposing it to have been the best offered, we must perforce conclude that all the others had still less to recommend them. It is not enough that those in whom the power of deciding is vested on such occasions, act impartially and according to the very best judgment, if they are at the same time deficient in the judgment required for acting properly. Where mischief is committed, it is not remedied or even lessened by honesty of intention; nor is such honesty especially manifested when responsibility of any kind is evaded by studious concealment of all the proceedings in committee. That in a competition of any importance at all, the committee consists of highly respectable individuals, is hardly for a moment to be doubted; and if never so before, they become *ipso facto* on that occasion, "influential" ones likewise. They may, too, be very intelligent ones, besides; yet, if they are unacquainted with architecture, their influence and their intelligence in other matters will not at all benefit the matter immediately in hand. In buying pictures —except, indeed, it be those which a certain Sir Charles picks out for John Bull to pay for—more discretion is generally shown; for if a person does not care to rely entirely upon his own judgment, he seeks the advice of some one of approved skill and experience in the merits of paintings; whereas the selection of a design for a building put up to competition, is frequently entrusted to and undertaken by parties who, so far from being qualified for such task, perhaps scarcely understand the drawings submitted to them.

It is not the least evil consequence of the impenetrable secrecy in which the proceedings of committees are shrouded, that those who, conscious of their own incompetence to deliver any rational opinion, would shrink from publicity, make no scruple of thrusting themselves forward, and officiously intermeddling in what they are very imperfectly acquainted with, if acquainted with at all. Private individuals cannot be controlled: they are accountable to no one, therefore must be left to indulge their taste, be it ever so preposterous, without incurring other penalty than that of critical animadversion upon it. With public buildings and competitions for them, it is altogether different: committees do not act solely for themselves, but exercise only a delegated authority, for the due discharge of which office they are, presumptively at least, answerable, first to their constituents or those whom they represent,—those who entrust them with their special power; and, secondly, to those whom they invite to send in designs, for as all but the two who obtain a premium—little better, perhaps, than a nominal one—must render their services gratuitously, they are entitled to decent consideration, if nothing more. Instead of which, they are sometimes treated with anything but either respect or liberality, being compelled first to pay a fee for the requisite instructions, and afterwards to bear the expense of sending their drawings, and receiving them back again—a mere trifle, indeed, still an additional drop of bitterness in the cup of disappointment that might very well be spared.

What is not least of all vexatious in so-called public (though, in reality, privately) managed competition, is, that an architect has no assurance of his drawings having been fairly examined. Rarely does any other design than the chosen one, and that to which a premium has been awarded, obtain mention of any kind; all the rest being passed over in silence as rejected, and as if rejection were tantamount to positive condemnation. Yet, at any rate, various degrees of merit among them there must be. Nay, some may be in certain points even superior to the one chosen for execution, as being the most eligible upon the whole—superior in taste and genuine artistic quality, whatever may have been alleged against it in other respects. The recognition of talent by making honourable mention of it, would be encouraging to an architect, and cost a committee nothing,—except that it might tax their power of discernment rather too heavily. Those who

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engage in competition have surely some right to learn what has passed in committee,—not only their decision, a fact that becomes patent to every one, but the manner in which it was arrived at, together with all the *pros.* and *cons.* of argument on both sides. To suppose that nothing like discussion takes place on such occasions,—that no remarks at all worth attention, are ever made, would not be particularly complimentary to committees. We rather incline to believe that very good common-sense observations, by which architects themselves might profit, must sometimes be made. It could be of no disadvantage to an architect to know what were the objections urged against his design when it came under consideration. Although a design is thrown out, it does not follow that it has not been distinguished from the general herd of the "rejected," by obtaining several voices and wishes in its favour. Hardly is it to be imagined that the ultimate decision is in every instance carried unanimously. Whenever it is so, we ought to be so informed; and in other cases, the majority and minority of votes ought to be declared, at least if there has been a strongly contended match between two particular designs. In all likelihood, matters are sometimes so nicely balanced between them, that at last only a casting-vote flung into one of the scales decides the affair. It may, too, be nearly the same with regard to a design that has obtained a premium and one that has not, in which case the latter is surely entitled to the distinction of being publicly named. It ought to be borne in mind, that in questions of architecture or other art, the truer judgment is quite as likely to be on the side of a minority as the contrary. Numerical strength is no very convincing proof of superior intelligence; yet we should perhaps be better reconciled to the results of certain competitions, could we but learn what had been urged in favour of the successful designs, for they ought to possess no ordinary merit in other respects to counterbalance their obvious shortcomings in point of architectural quality. To understand the exact why and wherefore of the paramount preference a design has obtained, is not a little desirable.

A "limited" competition, being also a private one, may without much impropriety be conducted quite privately, since it is confined to the few individuals in the profession who are actually invited to engage in it, and each of whom sometimes receives a certain gratuity for his trouble. Whereas, a public competition, thrown open to the profession at large by means of *public advertisement*, is a different affair altogether. Many—some of them perhaps trusting to the want of discernment and taste in committees—are induced to waste time, and incur expense also, in preparing drawings, in doing which they are, oftener than not, compelled to work most harassingly against time,—working all the while in distressing doubt and perplexity. Those who by advertisement call for designs, seem to have no idea of the preparatory study—consideration, at least, which the particular subject requires. They think, apparently, that architects keep by them an assortment of ready-made patterns available for all occasions, and that the preparing a design is accordingly only mere handwork, for which the time allowed may be sufficient, though sometimes hardly that. At the very best, those who engage in competitions labour under considerable disadvantages. When employed by a private client, an architect can freely confer with him, can ascertain his wishes in regard to numerous particulars too minute to be included in general instructions, can perhaps overrule frivolous objections, and bring his employer over to his own views. At all events, he is relieved from doubt and indecision in regard to the choice of style, that being a point settled beforehand between himself and his employer.

It is impossible to ascertain the amount of labour—the far greater part of it completely labour in vain—which Competition has entailed upon the profession in the course of the last twenty-five years, but it must be something prodigious. It affords us therefore no small degree of satisfaction, to find that the course adopted by the committee for the Liverpool building, and which we hope will become a precedent, will materially abridge the task of preparing drawings, only three or four "sketches" on a small scale being asked for in the first instance. After all have been examined, a certain number of them will be returned to their respective authors, in order to be worked out fully on a larger scale, for the second or decisive competition. Excellent as it appears to ourselves, this course has been objected to, on the score of its being impossible to show beauty of detail upon so small a scale: very true, yet for that same reason, merits or deficiences in general composition will be all the more evident. What is satisfactory—at least promises well, in its comparatively rough and nude state, will hardly disappoint when it has received all its finishing touches; or if it should do so, it must suffer accordingly, by being rejected in the final competition. Mistaken, perhaps, we may be, but it is our opinion that no better mode than the one adopted by the Liverpool Committee can be devised; or if a better can be suggested, we should be most glad to be informed what it is. We consider the competition specially alluded to, to be a most important experiment, which, if at all successful, can hardly fail to produce a very great change for the better in the actual system of competition, which is in many respects so rife with corruption and abuses, that it can scarcely be worse. In fact, the architectural profession have been by far too submissive and supine; and because, as far as their own immediate personal interests are concerned, competition may be matter of perfect indifference to them, those whose status and influence could not fail to command attention and give weight to their opinions were they to take the initiative in competition reform, stand coldly aloof, without so much as expressing any opinion at all. Nevertheless, a move in the right direction has at length been made, and—what was not at all to be anticipated—made by Committees themselves. Our readers are already informed that the Liverpool Library Committee require from competitors only four small sketches in the first instance; and the committee for the extension of the Liverpool Exchange "are willing to receive designs *in pencil*." Surely the sun is rising in the West instead of the East, when we find the dawn of what promises to be a better day for those who engage in architectural competition, breaking forth not in the longitude of London, but in that of Liverpool.

ARCHITECTURAL IMPROVEMENTS OF LONDON.

No. II.

In our prefatory remarks on the above subject (*ante* p. 121), we commented on a structure at the corner of Chancery-lane and Fleet-street, the principal materials used in the construction of which were white Suffolk bricks and Portland stone; in the same classification therefore, both as regards materials and style, we shall resume the matter by describing two other buildings,—the first of which has recently been erected for Messrs. Smith and Son, the eminent British and Foreign newspaper agents and booksellers, at the western corner of Arundel-street and the Strand. The second is a large pile of buildings now in progress in Cannon-street west, for Messrs. Berens, Blumberg, and Co., the British and Foreign fancy warehousemen. In reference to these very extensive business premises, and various others of a similar nature now in course of erection in the city and the eastern end of London, we may be allowed to affirm, that for substantial and appropriate construction, in conjunction with elegance of appearance, these structures will yield to none of a like nature in Europe; and when we reflect upon the immense aggregate amount of business that is daily transacted within their walls, we may justly say, as was said of Venice, that truly our metropolis will eventually become a city of palaces, as it is already a city of merchant princes. In the edifice erected for Messrs. Smith and Son, Mr. H. R. Abraham, the architect and surveyor of the Arundel estate, has employed the elements of Italian design, without, however, adopting the Palladian column-and-pilaster arrangement, which no doubt was deemed unnecessarily expensive and too ornamental for a building to be devoted to commercial pursuits only. This large pile occupies the sites of what were formerly Nos. 184, 185, 186, and 187, in the Strand, and Nos. 1, 2, 3, and 4, in Arundel-street, having a frontage in the former of 62 ft. 6 in., and a return frontage in the latter of 103 feet. The main portion of the edifice consists of a basement, ground floor, one, two, and three pair, with an attic of which the return in Arundel-street extends to the distance of 52 feet only, the remainder being merely carried up to the height of the one-pair, the latter being lighted, in addition to the side windows in Arundel-street, by a domical light of 38 feet in diameter. The whole of the basement is executed in Portland stone, together with the dressings for the windows, cornices, stringcourses, and parapets, the plain facings of the walls being of white brick. The builders were Messrs. Lucas, Brothers, whose contract for the whole of the works was under 20,000*l.*, and somewhat less than the original estimate, arising from deviations which were made during the progress of the work, by which savings were effected on the total outlay intended. The ground-floor and basement are entirely

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used for the extensive business operations of Messrs. Smith and Son, as also the greater part of the one-pair story, which contains a spacious open gallery under the glass dome to which we have already adverted. The other portions of the building are devoted to dwelling purposes, and are fitted up with every attention to domestic convenience and comfort. The heights of the different floors are as follows, viz. the basement from floor to floor, 11 ft. 6 in.; ground-story, 16 ft. 9 in.; one-pair, 15 ft. 9 in.; and the upper floors in the usual proportion. As we have already stated, the style adopted is Italian. The basement and ground story are composed throughout of rustic work, with the door and window jambs and quoins rendered more expressive by the introduction of stones the faces of which are roughed. The basement is surmounted by a cornice embellished with plain Ionic blocks. The first-floor partakes more of a decorative character, although no enrichments are employed; the windows have architraves around them, and finished at top with moulded segmental and pedimented heads, supported by trusses. The three upper stories are all finished in the ordinary Italian manner, being gradually plainer according to their altitude. The whole is surmounted by a bold and well-proportioned cornice, without that excessive projection and heaviness which oppresses the eye on examining some of a similar kind in buildings recently erected. This cornice is crowned with piers, the spaces between being filled in with balustrading, with the usual coping; we may remark, also, that the principal cornice in the Strand façade is continued *across the gable* at the western end of the building, and not cut off abruptly at the street elevation, as we frequently see, or returned on the face of the front wall.

The building erected for Messrs. Berens, Blumberg, and Co., is from the designs of Prof. Hoskings, and its more prominent features are also in the Italian style. The basement and sub-basement consist of rustic work, which extends to the top of the first-floor story, the whole being composed of Portland stone, which possesses one noticeable peculiarity, viz., that the chamfers of the rustics, instead of being plain, are embellished with an ogee moulding, giving them a richness of effect that is very satisfactory. This rustic work is surmounted by an appropriate cornice. The first-floor has pretensions of a still more decorative character—not, however, purely Italian in its details, inasmuch as the heads of the windows are finished with a peculiar horizontal cornice of novel character, above an architrave of the ordinary kind. The next story contains square-headed windows, but those above are circular-headed, and rest on a string-course. The attic windows are square-headed, having no sills, the architrave finishing all round. The upper cornice is supported by moulded trusses, and the horizontal line of the parapet is broken by ornamental stone vases. The angle of the edifice next to Distaff-lane is chamfered from the basement to the whole height of the elevation, which is 78 feet, and, having a considerable amount of decoration bestowed upon it, has a very good effect. The depth of the structure is 100 feet, and its frontage 60 feet; and as a whole is an excellent example of sound, substantial construction. The main timbers are of oak, and its general external appearance is that of elegance combined with utility.

In passing, at present, from some of our London improvements that are constructed of stone and white bricks, we shall proceed to notice the more prominent of those in which coloured materials are employed externally, such as yellow, red, and black bricks, Minton's tiles, and magnesian limestone. In doing so, it is desirable to make some brief remarks in reference to those particular materials when they are used for building purposes. We shall, therefore, in the first place, call the attention of our readers to a very early specimen of red brickwork forming the southern side of Christ's-Church school, in order to illustrate what can be accomplished in this material. The particular portion of the school alluded to was erected, in 1686, by Sir Robert Clayton, an alderman of the city of London; it consists of a façade of considerable length, embellished with a large segmental pediment in the centre, and triangular ones at each end, under the eastern one of which is a niche containing a statue of Edward VI., flanked on each side by pilasters in pairs, with Ionic capitals and attic bases, all admirably worked in red brick; the intermediate portions between the smaller pediments of the front are also embellished by pilasters in the same style, and the plain surfaces are all composed of rubbed brick, which, after an exposure to our trying climate during a period of one hundred and seventy years, appear in excellent preservation, and much more beautiful in colour, owing to the peculiar influences of the atmosphere, by which it has assumed a sort of rich red-brown tint. The eave-cornice of this building is of wood; the roof is composed of the ordinary small, flat red tiles, which no doubt were made of the same clay as the bricks of which the front of the building is composed. Amongst the most important edifices that have been constructed in London of red bricks and stone in conjunction, during our own time, are the Law Courts in Lincoln's-inn-fields, in the Tudor style, which, in many parts of the design, are very satisfactory, more particularly in reference to the chimneys, the proportions of which are admirable and their execution excellent; but we must take especial exception to the practice of inserting in the walls those obtrusive lozenge-shaped chequerings of vitrified black bricks (however good the authority for their introduction), that serve only to destroy the harmony and repose which ought to reign undisturbed in the general design of an edifice aiming at anything like perfection. It is likewise much to be lamented that the magnesian limestone employed in the quoins, window-jambs, and tracery copings of the basement walls, &c., is already decomposing to a most frightful extent, although the building has been erected not more than eleven years. This result should, we think, teach professors of architecture to exercise the utmost caution in the selection of all materials which they use, so that the wear and tear of each should be, as nearly as possible, equal; for in this particular instance we may safely say, that in half-a-century the brickwork of this building will be scarcely injured by atmospheric effect, whilst the stone portions will be found in a state of complete dilapidation.

If we were to give a hint to the designers of brick buildings, whenever they wish to introduce much ornamental work, we should advise them to use terra-cotta, which is nothing more nor less than burnt clay, which, by good management, can be formed into all kinds of mouldings and enrichments with the greatest facility, and would harmonise better with the plain surfaces than by using the violent contrasts of glaring red brick and straw-coloured stone, besides the advantages of equal durability and much less expense.

Another somewhat extensive adaptation of coloured bricks is illustrated in the new church in Margaret-street, Cavendish-square, in which many features of Lombardic work are introduced, such as inserting in the general construction horizontal layers of red and black bricks alternately in the plain walls. With this peculiar treatment we have the same fault to find as intimated above in our reference to the vitrified chequered work, namely, that it cuts up most abruptly the general effect of the whole composition, besides being directly opposed to all the true principles of mediæval architecture, which is essentially *vertical* in its tendencies, and not horizontal. Stone is also here used for all the jambs and tracery of the windows, pinnacles, and other ornamental portions of the church, the crockets and finials being rude and barbarous both in their design and execution. The spire is carried up to a considerable altitude, but is poor and tame in its effect for want of due expression at the point where it springs from the tower.

After alluding to this example of ecclesiastical Lombardic, we shall direct the reader to two samples of domestic architecture in the same style. The first forms one corner of Tavistock-street, in Southampton-street, Strand; and the second is situated at the angle of Duke-street and Buckingham-street, Adelphi. The former of these buildings presents a somewhat startling and fantastic appearance, and consists of four stories surmounted by a clumsy heavy cornice, upon the centre portion of which is placed a most unmeaning mass, composed of stunted columns, and a series of dwarf arches resting on brackets, over which is a still more clumsy cornice in bright red bricks, which, when viewed laterally, has a most frightful appearance, as if the first heavy gale of wind from the west would topple it over on to the roof. A very considerable amount of embellishment has been bestowed on both the elevations of this building, the ground story being composed of red and yellow bricks in alternate horizontal rows, surmounted by a cornice done in cement. The entrance consists of the usual dumpy columns and circular-headed arch peculiar to the style; the plain surfaces above the ground-floor to the upper cornice are in yellow brick; all the windows are semicircular-headed, worked in a peculiar manner with *rubbed* red bricks, or narrow wedge-shaped insertions of black, and in some instances cross-shaped pieces inserted alternately. The arches of the windows rest on columns, which with their capitals are of stone, the latter being carved from natural

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leafage, fruit, and flowers, such as hop, maple, vine, &c. One peculiarity of some of the windows is, that their voussoirs are not carried round the arches parallel, but commence at the width of the abacus of the capital at the springing, and increase in breadth until they reach the crown of the arch, but only towards the upper edge, which forms on the upper line a pointed arch, while the soffit remains semicircular, like what may be seen in some Italian examples in the Broletto of Como, and the windows of the Broletto Monza. The leafage and flowers of the capitals are well cut, but there is a clumsiness about the proportion of some of the windows that is highly offensive.

Our second specimen of the style to which we are adverting, is also composed of four stories above the street level, and contains no basement. The entrance is in Buckingham-street, formed by one of those gouty, dyspeptic porches, with their short columns and capitals of foliage, such as you may "touch with your hand," and are so much the delight of Mr. Ruskin. The usual round-headed arch springs from these capitals, and the roof forms an acute pediment, covered with two huge pieces of dark purple-coloured slate, forming a whole of the most unmitigated ugliness and horrible proportion that could well be conceived. The usual circular arches are used for all the windows throughout both the fronts, the voussoirs of which are composed of red rubbed bricks, supported by pilasters in stone with enriched capitals. The elevations are terminated by a cornice, the frieze of which, together with the stringcourses, have insertions of Minton's tiles in geometric patterns, in green, white, and purple. The plain portions of the walls in the ground-floor elevation are formed of alternate courses of red and yellow bricks of three bricks deep each, in the usual striped fashion peculiar to the style.

Some of the most prominent characteristics of the Lombardic manner of building, are the alternate mixture of horizontal insertions of different-coloured bricks and stone, or black marble and bricks, as is the case in many of the buildings in the northern states of Italy; round-headed and pointed arches in the same elevation; projecting shelves under windows supported by stone brackets; arcaded eaves-cornices, elaborate, heavy, and egregiously ugly; oppressive weights upon slender-shafted columns, which generally rest upon their simple base, without pedestals; the arch springing direct from the capital, without architrave or entablature. In fact, the Lombardic architects, or rather builders (for they do not deserve the name of either architect or artist), may be said to have rejected all the regular set rules of accurate proportion and taste which had been adhered to so correctly in classic times, so that we can scarcely wonder at the clumsy abortions which they produced in their domestic architecture. The same amount of condemnation may also, in most instances, be awarded to their ecclesiastical edifices; for let any unprejudiced observer examine, as instances, the churches of Pavia, viz., San Michele, San Pietro Cielo D'oro, and San Teodoro, and he will find that they are, one and all, stiff, formal, and unartistic, and have been conceived without that due appreciation of the correct distribution of ornament on their surfaces that tends so much to produce true harmony of effect, so highly desirable in good architectural composition, and which forms one of the greatest secrets of the art. In most instances the external embellishments of those churches are thrown to the upper stories of the campaniles, while the lower portions are left bald, mean, and unimposing. In many examples also, in their interiors, the vaultings of the roofs spring directly from the abacus of the capitals of the columns, above which we sometimes find pilasters carried up the walls, and finished with capitals, the mouldings of which are of Roman detail. Such are the manifold faults and corruptions of this debased style, that it is with the greatest surprise we find it revived in any shape or form, and we trust it may at once and for ever be abandoned, being of no use whatever, except in an historic point of view.

Whilst we are adverting to buildings wherein coloured materials are employed, we may also direct the attention of our readers to the Panopticon in Leicester-square, in which another distinct style has been inaugurated with partial success; but why we are to travel to Grand Cairo, or any other oriental city, for our models, when we have so many better much nearer home, we are perfectly at a loss to discover, unless it be for novelty's sake only. We shall not, however, deny that there are many useful hints in outline to be obtained from some of the eastern minarets and martello towers, many of which are highly picturesque; but we think it is utter degradation in us to copy directly, and as a whole, the works of a Mahomedan race of people, whose religious creed, habits, and climate, are so very different to our own.

REVIEWS

An Impulse to Art; or, Ancient Greek Practical Principles for Volutes and Lines of Beauty innumerable. By JOSEPH JOPLING.

A Key to Proportions of the Parthenon. By JOSEPH JOPLING. Nos. I. & II. London: Published by the Author.

Of these two treatises, which bear upon one common subject, the minute and infinite phases of beauty as derived from geometrical sources, and adapted to optical effects, the former has been issued several years, the latter quite recently. In the precise line of study which the author has chosen he travels an almost unbeaten path, one beset with no little difficulty both to himself and those who may venture with him. That Mr. Jopling is an enthusiast is at once apparent, and it might almost be thought from his "impulse" that he has discovered the philosopher's stone, at least so far as Greek art is concerned. It is more than thirty years since he began his investigations, which are based on mathematical formulæ, and by their aid he invented an apparatus for the organical description of curved lines, which received the approbation of Dr. Olinthus Gregory, Tredgold, Peter Nicholson, and other distinguished men, and by the assistance of which he was enabled to prepare accurate full-size moulds of the entasis of a memorial pillar, 80 feet long, which he erected in Ammerdown-park, Somersetshire. As the author allows "reviewers, when convinced of the fact, to state that while one end of a definite distance (a rod of any length) is carried round a circle *once*, the other end may be taken *twice* round another circle, but are respectfully solicited not to publish how this can be done," we can only say that by the means laid down, a series of gradually spiral lines,—in the correct sense of the word,—may be described with unerring certainty. The secret here explained, it is considered, was known to the Greeks, and used in the curves of their Ionic volutes and elsewhere; certain it is, that the form of the noble Erechtheum capital cannot be described, like some debased and Roman examples may, by a succession of quadrants. The ingenuity of Mr. Joplin's scheme reminds one of the *cymagraph*—the instrument invented by Professor Willis for transferring to a flat surface, from the originals, the precise outline of mouldings, and their relative position; an invention which has not been yet turned to that useful account of which it is capable.

The 'Key to the Proportions of the Parthenon' owes its origin to the researches of Mr. Penrose, as defined in his elaborate work, a model of care and patience, and which shows, if the writer be correct, that the artificers of those days were possessed of an amount of mathematical skill to which few in the present age can lay claim, and were endowed with delicate perceptions and optical refinements, now, through want of exercise, almost utterly ignored or unknown. The fact that these curious niceties were observed even in the curvature of the upper steps, instead of making them perfectly horizontal, would not be credible but for evidence which leaves but little room to question it. On this point our author says—

"Supposing stakes or blocks of stone to be fixed outside at the four angles of the temple, and to and from these the mason's lines fixed and stretched, at ends and sides, by which to guide the workmen to set the blocks for the upper step:—the thought occured to the author that, although on a horizontal plane, these mason's lines would appear as right lines: yet, as they would swag, on vertical planes they would be catenary curves: and that just as much as these may be below a horizontal line at every point, if set off as much above, might give the delicate curve of the top of the upper step, at any number of points.

"This very simple method on trial has been found to be correct. Exactly coinciding with Mr. Penrose's points. Thus the ancient Greeks knew and applied in architecture, catenary curves!!"

In the Architectural Museum, at Canon-row, is a full-size model of one of these steps, and also the curve of the entasis the full-length of a column: these were prepared to illustrate a lecture delivered there last May, and they remain for the inspection of those interested in such matters. But it will occur to all, as to the author himself, before so many results as have been obtained from the length of the end upper step of the Parthenon by the train followed, it will be manifest that—First, such must have been the laws of the original design;—Second, the work must

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have been accurately executed;—Third, sufficient of the temple must have endured for twenty-three centuries;—Fourth, that the measurements made by Mr. Penrose must clearly have been as carefully made as the original work was executed. Numerous comparative tables of measurements compiled from Mr. Penrose's work, and embracing even the minuter portions of the edifice, are placed side by side with calculations deduced by Mr. Jopling, from his own system, and the figures—strange to say—coincide in most cases within an inappreciable decimal. For instance, in the length of one of the upper steps (101·440 feet) the difference is only ·073 (!!) which "allows for space for mason's line to hang clear of work—for any minute error in original setting out and in workmanship—also for alterations by time during more than 2000 years—and for any inaccuracy in the measurements by Mr. Penrose." (!)

In following out these calculations the frequent occurrence of one number or *unit*, viz., 1·40888 (taking the English foot at 1·000), it is surmised whether this may have been some standard measure of the ancient Greeks. Mr. Jopling designates it the *Pivot* (Parthenon).

A variety of diagrams and arithmetical calculations are introtuced in the other pages of the pamphlet, which tend to show the indefatigable perseverance of the author; but, beyond this, and the archæological value which attaches to such investigations, we doubt if they will be productive of much practical benefit. The demands of the present age are essentially different from those we have been contemplating, our climate and materials far more treacherous; and there is little scope in these railroad times for indulgence in delicious fancies or ingenious toying. But, to those individuals whose inclination leads them to study abstruse or the occult sciences, who revel in the intricacies of conic sections, conchoids, cissoids, and the like, an ample field is open, and it would be unwise for them to neglect its cultivation.

A Catechism of the Steam-Engine. By JOHN BOURNE, C.E. Fourth Edition. London: Longman. 1856.

This excellent manual has reached a fourth edition, and in its present form it is more valuable in many respects than the preceding ones. The author has divided the book into chapters, he has added new matter, and has considerably improved the arrangement, in addition to making the emendations which the progress of science required to fit it to the existing state of knowledge. "The design I have proposed to myself," says the author, "in the composition of this work, is to take a young lad, who knows nothing of steam-engines, and to lead him, by easy advances, up to the highest point of information I have myself attained." This object has been carried out very successfully, and the catechism of the steam-engine is, consequently, not merely an elementary book, but is a compendium of the principal facts, theoretical and practical, connected with the different applications of steam-power. The following observations on the strength of boilers afford a sample of the style in which the information is given:—

"The question of the strength of boilers was investigated very elaborately a few years ago by a committee of the Franklin Institute in America, and it was found that the tenacity of boiler-plate increased with the temperature up to 550°, at which point the tenacity began to diminish. At 32°, the cohesive force of a square inch of section was 56,000 lb.; at 570°, it was 66,500 lb.; at 720°, 55,000 lb.; at 1050°, 32,000 lb.; at 1240°, 22,000 lb.; at 1317°, 9000 lb. Copper follows a different law, and appears to be diminished in strength by every addition to the temperature. At 32° the cohesion of copper was found to be 32,800 lb. per square inch of section, which exceeds the cohesive force at any higher temperature, and the square of the diminution of strength seems to keep pace with the cube of the increased temperature. Strips of iron cut in the direction of the fibre were found to be about 6 per cent. stronger than when cut across the grain. Repeated piling and welding was found to increase the tenacity of the iron, but the result of welding together different kinds of iron was not found to be favourable. The accidental over-heating of a boiler was found to reduce the ultimate or maximum strength of the plates from 65,000 lb. to 45,000 lb. per square inch of section, and riveting the plates was found to occasion a diminution in their strength to the extent of one-third."

A letter from Genoa states that Mr. Brett, director of the Mediterranean telegraph, has been invited to lay down as promptly as possible the submarine cable which is to open a communication between France and Algeria.

THE ARCHITECTURAL MUSEUM, CANON-ROW.

THE first general meeting, for the present year, of the Society formed at the Architectural Museum, Canon-row, Westminster, took place on Monday evening, April 7th, upon which occasion the prizes for stone and wood carvings were awarded. There was a very full attendance. Professor Cockerell was unanimously voted to the chair, supported by A. Beresford Hope, Esq., Sir Walter James, Bart., Mr. Ruskin, Mr. Scott, Mr. Digby Wyatt, Mr. Raphael Brandon, and others.

The learned Professor, in opening the proceedings, expressed the pleasure he felt in being called upon to distribute those prizes to aspiring artists that, sooner or later, were always reaped, as the reward of perseverance in the pursuit of a noble calling. The genius of this country had never been deficient in the arts of peace; but if a deficiency did exist, it was mainly attributable to a want of fitting opportunity, and *the absence of that generous and enlightened patronage*, which the gentlemen of the Museum had conceived, and were practically carrying out.

Having prefaced the proceedings with these few remarks, the Chairman called upon Mr. RUSKIN, who had offered the first prize, and who now presented it to a young man only 18 years of age, whose productions were full of invention and talent. Mr. Ruskin observed, that he felt gratified in being permitted by the Committee to offer this particular prize. He waived some of his own crotchetty views, and he hoped the Committee would agree with him in the award he had just made. Whatever might be the views of various architects among them, they would be unanimous in this point, that great excellence was only to be attained by close observance of natural objects. They would all agree that the carvings of Grinling Gibbons were beautiful, because they looked like roses and lilies; that the Elgin marbles were beautiful, because they looked like Greek heroes; and that the beauty and excellence of a Phidias, a Praxiteles, or a Grinling Gibbons, could in no way be attained but by directing the workman to the study of nature. Mr. Ruskin then presented Mr. William Sandilands with the first prize, for stone-carving, amounting to five guineas.

Mr. SCOTT now introduced Mr. John Baldwin, to whom the Chairman presented the first prize for carving in wood. Prizes were also presented in a like suitable manner to Mr. Forsyth for wood-carving, and to Mr. Galping for carving in stone.

Mr. HOPE then addressed the meeting, and stated that their object for assembling that evening was one of common gratification, remembering, as he did, the meeting twelve months ago, out of which the present one had sprung, when they had enthusiastically determined that there should be prizes for artizans. And after some further comments, the Chairman introduced Mr. Digby Wyatt to the notice of the meeting.

Mr. WYATT thought that there was no one who had attentively studied the late Exhibition at Paris, but would admit that the artizans had shown as skilled a condition of things as in any period of the history of art. He, Mr. Wyatt, contended that the Ecole de St. Martin, in Paris, was a model for imitation; it contained the greatest number of the working classes, and the government made provision for teaching drawing, geometry, and modelling, and where the pupils elected themselves into committees, representing the different trades and arts. He did not say that the English workman was not so good, but he was surrounded by difficulties, and it was hard for him to obtain efficient means of study.

Mr. ASH, an art-workman in the manufacture of iron and brass-work, here made some comments on the requirements made by the Committee for the prizes of the present year, contending that, instead of going back to the 13th century, the prize for iron-work should embody an example of design and execution of the 19th century.

Mr. HOPE presumed that the Committee preferred the metal-work of the 13th century, because the ironwork of the Greeks and Romans had gone to rust long ago.

Mr. SCOTT announced that Mr. Hope had offered a second prize for ironwork, and afterwards proposed a vote of thanks to the Chairman, who responded in a very feeling and appropriate manner, when the meeting broke up.

In reference to the prizes which have been awarded, and also those which have to be competed for during the current year, it may be remarked that, however generous the Committee and

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other patrons of art may be, it is to be lamented that they confine their teachings exclusively to the encouragement of mediæval carvings and workmanship only; for every one must admit, that there is another style becoming more generally adopted amongst us, which is the Italian, as founded by Brunelleschi, Bramante, Palladio, and their distinguished followers, amongst whom may be enumerated our own Inigo Jones and Sir Christopher Wren, the latter of whose works were decorated by the carvings of Grinling Gibbons, who was so especially adverted to in terms of high encomium by Mr. Ruskin. It is therefore suggested that some encouragement should be given to art-workmen in that peculiar style of embellishment, which is most appropriate to the decoration of the best Italian architecture. It must be confessed, when we look around and examine many most inferior examples which have been produced in some of our buildings during the last twenty years, that there is undoubtedly ample room for very considerable improvement, more particularly in design. But, in this respect, we shall not have much of either faith or hope, unless, as Mr. Digby Wyatt so earnestly enforced, there should be a better and more friendly understanding between the architect and the art-workman; for, as he went on to observe, "in the middle ages they knew very well that the art-designer was himself the art-workman." Further, it is known, however unwilling we may be to admit it, that there is not one architect out of fifty who can really design ornament well, and with facility; and it is also well known, that Wren was indebted to the head as well as the hands of Gibbons, to a very considerable extent, in the consummate embellishments of the best of his architectural works.

In bringing prominently forward the name of the inimitable Gibbons before our readers, we may direct attention to his decorative stone-carvings which adorn the exterior of St. Paul's cathedral, and also his works in wood at Chatsworth, which, for successful grouping and dexterity of handling, remain as yet unequalled—supreme and alone—and fully justify the happy expression of Allan Cunningham, namely, that "stone beneath his touch became as vegetable life, and wood as lilies of the valley." This being the case, is it not very desirable that two prizes should be given for carvings in stone and wood in the Italian style, now that it is becoming so universally adopted in the public buildings and street-architecture of the metropolis and most of our provincial towns? This step, it is presumed, would still tend to make the Committee and supporters of the Architectural Museum more popular than they are at present, and would, it is hoped, infuse some fresh blood into the arteries of the institution, as well as take away from it that class character which it possesses in adopting exclusively the mediæval styles. In holding up Gibbons as a model for carving we do not suggest that his works are to be slavishly copied, for, with all his excellencies, we are aware that in some respects he was not perfection, and, in particular qualities, much inferior to Ghiberti. It is, therefore, earnestly hoped that some of our young artists will endeavour to embody in their productions the feeling and characteristics of both these great men, when assuredly they would achieve for themselves an "immortality of fame," hitherto unknown in the history of the plastic arts, by catching a portion of that spirit which is pourtrayed in some of their yet inimitable conceptions.

It is believed, if the proper authorities were applied to, that permission would be given to take impressions from many of the works of Gibbons, within and about the exterior of St. Paul's, which would afford valuable hints to students in the art of modelling and carving, and aid them very materially in forming their taste.

If Mr. Ruskin does nothing more, he creates, at any rate, a large fund of amusement, by the facetious and eccentric manner in which he puts forward some of his "crotchetty" notions, which are quite peculiar to himself. He appears at times to be "having a game" with his audience, and yet all the while maintains an expression in his face of extreme gravity.

We confess that it would "puzzle a conjuror"—even the "Wizard of the North" himself—to unravel some of those paradoxical instructions which he is pleased to give. One of the prizes presented by him, for the current year, he says is *not intended* for *architectural information*, nor for "botanical research," but merely for "workmanly invention and skill." Now, Mr. Ruskin either knows, or ought to know, that a man who designs and cuts a piece of work out of the solid, such as he describes, must essentially be an artist, and must possess capabilities beyond those of a workman; he must also be endowed with genius into the bargain. Then, again, the architecture is to be either Gothic or modern English "cottages or old fashioned streets, or *pure brick* square-windowed" houses common among us; not adulterated bricks, but bricks of the greatest purity—real Suffolk "stocks;" neither are the buildings introduced to be "Greek or Grecised."

If horses are introduced, *their pace must not be faster than a trot;* there must be no prancing steeds, none of the ancient fire of Bucephalus in them—they must be of your true cart-horse breed, perfect Barclay and Perkins's dray-horses; neither, we presume, must they be mounted by riders of the heroic stamp, like Alexander. Everything in the composition must be quiet and orderly, and nothing but the sober jog-trot indulged in by the steeds; no energetic action, such as we so much admire in the celebrated Panathenaic frieze, and the alto-relievi of the immortal Phidias. What a tame, monotonous affair the sculptures of the Parthenon would have been, if Pericles had issued orders to the effect, that none of the horses introduced were to go beyond a trot;—why, the thing is the height, the very incarnation of absurdity.

Mr. Ruskin will perhaps excuse us for indulging in this little bit of badinage, for, we assure him, that it is done in the cause of *art*, and dictated in the greatest good humour, and not with any degree of splenetic rancour. We are also free to acknowledge that art-workmen, as they are called at the Museum, ought to be very much obliged both to him and to that generous patron of the arts, Mr. Hope. But we would seriously advise him to lay aside those nonsensical vagaries and inconsistencies in which he indulges, and not continue to render himself so perfectly ridiculous in the eyes of all intelligent men. We should also rejoice to see more liberality of feeling enunciated amongst the members of the Committee, so that they would not blind themselves to the beauties of Greek, Roman, and Italian art, but allow these styles a place in their Museum, as well as the Gothic, which latter they seem to consider the alpha and omega—the very *beau ideal*, of all perfection.

NEW MERCHANT OFFICES, OLDHALL-STREET, LIVERPOOL.

We are glad to find that Mr. James K. Colling is busily engaged for his patron, R. C. Naylor, Esq., of Hooton Hall, in erecting upon the open space of ground which has been lately cleared in Oldhall-street, between George-street and Ormond-street, Liverpool, a very fine and convenient range of merchants' offices, which we have little doubt, from their proximity to the Exchange, and the excellent and roomy sample and sales rooms which may be obtained, will be eagerly seized upon by some of our first and most wealthy merchants and brokers as soon as erected. The whole of the arrangements will be of the most perfect character, and the utmost attention will be directed towards producing convenient, well-lighted, and efficiently ventilated offices.

They will prove a great addition to the already much improved street architecture of Liverpool. The principal front in Oldhall-street will consist of a granite basement, supporting the ground story of rusticated stonework, above which is the principal story, which is to be arcaded and enriched with ornamented archbands, the arches above the windows being pleasingly filled in with carved foliage and lunettes of red and green polished serpentine marble, which doubtless will produce a novel and charming effect. Above the top story will come a bold and effective stone cornice and balustrade, below which again will be an enriched frieze and lunettes of red and green polished serpentine marble. The plain portions of the upper stories will be of red brick, which, with the serpentine, will form a pleasing contrast of colour with the stone.

The principal entrance archway, which will be in the centre of the front in Oldhall-street, will have polished red granite jambs, and the entrance will have an ornamental groined and panelled ceiling, supported on enriched columns with polished red granite shafts. Turning to the right and left, this elegant and tasteful entrance will lead to the principal staircases, and also to long corridors 12 feet wide, out of which the various offices open. These corridors will be lighted from above by continuous skylights, and the light admitted through the stories by open well-holes. In the centre of the whole building will be an open court-

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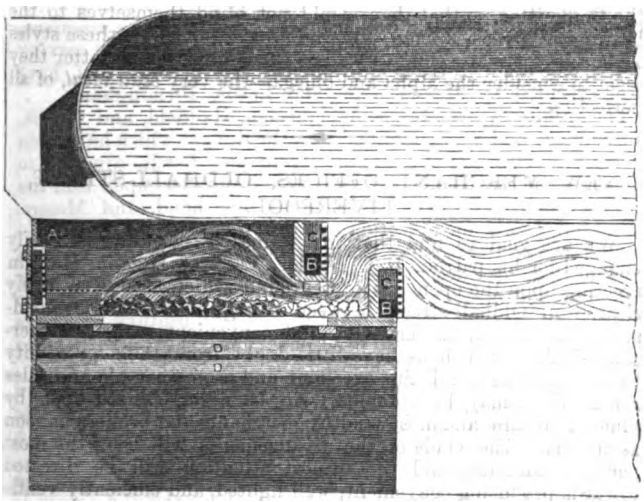
yard about 170 feet long by 35 feet wide, communicating with the front and side entrances, and admitting light to the offices. Across this courtyard two small bridges will be carried for communication from one side of the building to the other.

It will perhaps be the largest block of offices which have been yet erected in Liverpool; and to give some idea of the great extent of the whole building, we may state that the frontage in Oldhall-street is about 145 feet, and in George-street not less than 230 feet. There will be between 60 and 70 complete sets of offices, each provided with strong closet, lavatory, water-closet, and other conveniences. There will be also below the building two extensive ranges of fire-proof vaults, having crane entrances from the side streets.

In a future *Journal*, we shall endeavour to give some illustrations of this important range of buildings.

GARDNER'S SMOKE-CONSUMING FURNACE.

Sir—In your number for December 1855, you make some remarks upon "Gardner's Patent Smoke-Consumer;" and as a matter of justice to myself, I venture to ask your insertion of the following extracts, taken from my own and Mr. Gardner's specifications—premising, that my own patent bears date some seven months earlier than Mr. Gardner's. In my specification, it is stated, that "a hanging bridge is placed a little forward of the hinder or ordinary bridge, so arranged as to cause the products of combustion, which rise up from the fire in front of the bridge, to be directed downward below the hanging bridge," and that "the products of combustion rising up in the space between the two bridges, will be supplied with numerous streams of heated air." (The following engraving, similar to the specification drawing, will render the remarks more clear). And in my Paper on this subject, read before the Institution of Civil Engineers, some five months before the date of Mr. Gardner's patent, amongst other advantages for which that gentleman now claims credit, I stated, as a chief value of my invention, that "the peculiar position of the inverted bridge compels the flame and gases to impinge upon the incandescent coke or carbon lying upon the extremity of the fire bars, whilst the gases as they leave the fuel in distillation are entirely surrounded by small jets of atmospheric air."



We may now investigate Mr. Gardner's claim. I copy from his own provisional and complete specifications;—he says: "The said invention consists in certain arrangements of diaphragms" (simply bridges) "in the furnace, so disposed as to cause the products given off from fuel to pass through or in contact with the heated material on the fire grate, and to cause the so heated material and products to be brought into contact with sufficient supplies of air to produce combination therewith, and render their combustion perfect." And he concludes his complete specification by saying: "I do not limit myself to the precise detail herein specified, reserving to myself the exclusive right of using any other method substantially the same to all intents and purposes as those I have herein specified." Thus Mr. Gardner would claim the exclusive right of using my patent, for it is evident that both patents are "substantially the same to all intents and purposes." Mr. Gardner has made a few colorable alterations, every one of which is productive of mischief. I could easily explain myself more fully, but Mr. Gardner is on these matters evidently working in the dark, and it is no part of my object under present circumstances to enlighten him.

I can sympathise with those who wish to avoid Chancery, and yet are driven into it as the only way by which to secure their rights; and must caution all parties against the use of Gardner's patent, after this notice.

I am, &c.,

William Woodcock.

12, *Bishopsgate-street Within*,
April 17, 1856.

P.S.—I use the present opportunity to remark, in answer to complaints which have been made against Messrs. Goding, Jenkins, and Co., Lion Brewery, Lambeth, as to the amount of smoke erroneously supposed to be emitted from their copper-furnaces, that the furnaces alluded to are not upon the brewery premises, and do not belong to Messrs. Goding and Co.

The only furnaces situate at the foot of Hungerford-bridge, and belonging to the Lion Brewery, are five in number, all under my superintendence and care, and all communicating with the large circular shaft in the centre of the building, from the mouth of which as little smoke issues as from any chimney in London.

LILLE CATHEDRAL COMPETITION.

It is with much pleasure we are able to state that our fellow countrymen have carried off the honours in this competition. A public meeting was held on the 13th of April, at Lille, the Mayor in the chair, when it was announced that the first prize had been awarded to Messrs. Henry Clutton and William Burges, of London, and the second to Mr. Street, of Oxford; the third being given to M. Lassus, of Paris. The president of the jury, M. de Contencin, addressed the meeting and complimented the commission on the happy idea they had carried out, of appealing for designs to architects of all nations, and on the spirited manner in which their call had been responded to. The mottos or titles to the works selected for the different class of prizes were then read, and the names and addresses of the candidates announced, in addition to those already named:—

"Gold Medals"—Leblanc and Rimbaux, Rheims; De Curte, Ghent; Vincent Stratz, Cologne.

"Silver Medals"—Isaac Olden and Son, Manchester; C. Brodrick, Leeds; Geo. Evans and Richard Poplarel, London; Leroy, Lille.

"Honourable Mention"—James Lendon Pealey, Birmingham; Chas. Arendt de Greewenmacker, Luxembourg; Johan Muller, Cologne; Auguste Hostmar, Carlsruhe; John Robinson, London; Ferdinand Sdaler, Zurich; Ferdinand Kerchnez, Vienna; Geo. Goldie, Sheffield; Adhelmar Bouet, Caen. The jury specially noticed the last two on this list, and regretted not having the means of awarding to them a medal.

From the above it will be seen that out of ten prizes, five have been awarded to Englishmen. The exhibition of the designs excited intense interest in Lille, the crowds of persons anxious to view them being so great as to render it difficult to gain admission: in this respect a striking contrast to the indifference shown in London to the exhibition of the designs for Barracks, now open.

A new striking clock, conducted on a novel principle, called the galvano-magnetic clock, has just been erected at the Post-office, Lombard-street. The galvanic battery is used for actuating the movements of the instrument. The clock is suspended from a horizontal spar at the height of about twelve feet from the ground. It has three hands, viz., the hour and minute hands, and what is termed the "striking hand." The clock is set to Greenwich time daily at one p.m., and strikes by the agency of a direct current of electricity established between the instrument and the Royal Observatory at Greenwich. The Post-office authorities have selected Lombard-street branch as a site for the new magnetic clock by way of experiment, but the invention is to be immediately introduced at the chief establishment in St. Martin's-le-Grand, and the West end branch, at Charing-Cross.

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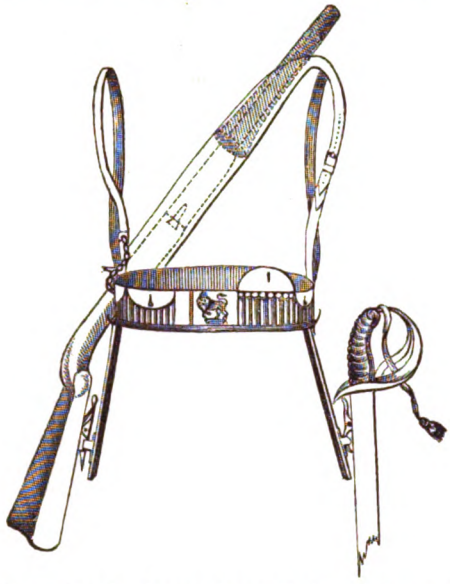
MILITARY BELTS FOR CAVALRY.

J. CHARLES KING, Portland-road, London, *Inventor*.



THE above sketch shows three distinct belts—Sword-belt, Carbine-belt, and Cartridge-belt, in the position as if being worn by a soldier.

The Sword-belt is simply a strap of leather passing over the left shoulder under the shoulder scales, reaching to the waist, there joining a broader piece of leather or frog, which reaches to the thigh; this frog is stiffened by a blade of metal looped at the top, for the adjustment of the cartridge-belt when worn filled with cartridges. A metal loop near the bottom of the frog, holds the sword by means of a spring clip fixed to the scabbard of the sword.

The Carbine-belt passing, over the right shoulder, is like the Sword-belt, with the addition of a strap passing from the frog across the back to the left shoulder strap; this back strap is fitted with a piping or ring to receive the muzzle of the carbine; a spring clip let into the stock, secures it to the loop on the frog of the belt, in the same manner as the sword. The swivel chain traverses the shoulder strap to which it is slung.

The Cartridge-belt is like the ordinary waist-belt, fitted all round with light metal tubes the size of a cartridge, fastened to the belt by a casing of thin leather, and having folding-flaps to protect the cartridges from wet. This belt is worn so as to slide freely round the body; its under edge, being half-an-inch below the row of tubes, rests or slides upon the loops in the frogs of the side belts. It is altered in size by one end of the belt-strap passing through the spring clasp, which fastens as a buckle.

In the trial of these belts, it was found that, besides being lighter than the belts now in use, they allowed the most perfect ease and freedom of action to the soldier whether mounted or on foot;—that the Cartridge-belt, carrying from 36 to 60 rounds, dispenses with the cross-belt and cartridge-box, which carries but 10 rounds;—that the sword hangs lightly from the shoulder, and steadily at the horse's side, without distressing the man, or annoying the horse, as at present.

The carbine is always slung, and when not being used, carried at the soldier's back, from which it may be removed without the aid of the rein-hand, by simply grasping the stock so as to release the spring clip, and drawing the carbine from the piping or ring on the back strap. To replace it at the back, the muzzle is slipped into the piping or ring, and the spring clip is pressed into the loop on the frog of the belt;—thus, while riding at any pace, the carbine may be strapped or unstrapped with the same ease as a sword is now drawn and sheathed: and with Leetch's Carbine, the operation of loading and firing is also effected with celerity without using the rein-hand.

The carbine, carried in this manner, has many known advantages over the old method of having it strapped to the saddle, by which it bruises the thigh and arm of the rider during his evolutions, and when dismounted in action, or for skirmishing, he is thrown away from his weapon; or if it happens to be slung, he has to carry it in his right hand, or let it dangle about his legs.

The sword and carbine may be detached from the belts in an instant, and, if necessary, the coat may be taken off or put on, without removing the belts.

ST. JOHN'S CATHEDRAL, SALFORD.

(*With an Engraving, Plate* XIV.)

THIS Church is cruciform, the upper arm of the cross being devoted to the choir and chancel, with ladye-chapel, chantries, and side aisles. The whole of this part, including four entire bays next to what is called the east end of the church, has been walled up from the nave for the last two years, at the point where the rood screen should divide nave from choir, with the object of completing the choir, and indeed all the internal work of that end of the church.

The choir, from the place of the rood screen to the high altar, filling three bays, is enclosed by side screens from the north and south aisles, with two entrances thence. At the lower end it will, for the present, be separated from the nave by the carved oak seats of the choir. At the upper end is the high altar, and its rich central canopied screen, with lower screens flanking it. The

The ladye-chapel has a private chantry on each side, the Lee chantry on the north, being founded by Daniel Lee, Esq., and the Leeming chantry, on the south, by the family of the late John Leeming, Esq. Each of these chantries has its altar and reredos, its windows of richly stained glass, and its canopied family tomb.

The whole of the masonary is of the finest Caen stone, with the exception of one altar frontal of the purest Derbyshire alabaster, and the columns of two small arcades which are fine specimens of the Devonshire porphyry. All the stone erections, sculptures, and carving, as well as those in alabaster, the carving of the oak seats for the choir, and the fine groined roof, have been executed by Messrs. Lane and Lewis, Birmingham.

The architects are Messrs. Weightman, Hadfield, and Goldie, of Sheffield; and we understand that the designs which have been so well carried out by Messrs. Lane and Lewis, are due to the genius of Mr. Goldie, and they certainly reflect upon him the highest credit. To Mr. Goldie on the one hand, and Messrs. Lane and Lewis on the other, is due the credit of proving—in no elaborate treatise like Ruskin's, but in the tangible, material work of their own design and execution—that we need no longer sigh after the mediæval work, as for glory departed never to return; but may confidently point to this 19th century work, as challenging comparison with most of that which we have hitherto deemed unapproachable by modern art.

In the present number of our *Journal* we present our readers with an engraving of the Altar in the Leeming Chantry (Plate XIV.), and will therefore at present content ourselves with a detailed description of that portion of the work.

This chantry is surrounded by a stone screen or parclose, the base of which is 2 ft. 5 in. in height, and above this the screen is an open one. This screen, on the side next the ladye-chapel, contains the founder's tomb,—a picturesque composition, consisting of a low ribbed arch, covering a flat tomb, on which is inlaid an elaborate brass, richly engraved and enamelled. On the ribbon of brass along one side of the slab is engraved: "Pray for the soul of John Leeming, Esq., benefactor of this cathedral and founder of this chantry, who died Sept. 9th, 1847. Jesu Mercy." The other half of the ribbon is left blank to commemorate some future occupant of the tomb. A small shield on the apex of the arch, and another on the brass, are blazoned with the family arms—Ermine, a cross potent, sable. The chantry altar (with its reredos) against the east wall consists of a very exquisite central niche, with a fine patriarchal statue of St. Joseph in the centre, and eight smaller niches on each side, with very graceful statuettes of angels bearing, alternately, scrolls and torches. Below are panels of lilies and roses; and the bracket on which the central statue stands is a chef d'œuvre of elaborate beauty, composed of hawthorn branches, almost detached from the "bell" of the capital around which they are entwined, with birds pecking at the fruit and flowers. The altar frontal is a lovely bas-relief of the death of St. Joseph, the group including the Virgin and the Saviour. The piscina, to the right of the altar, is a beautiful little gem of design and workmanship; the labels being terminated by angels bearing the typical grapes and water bottle.

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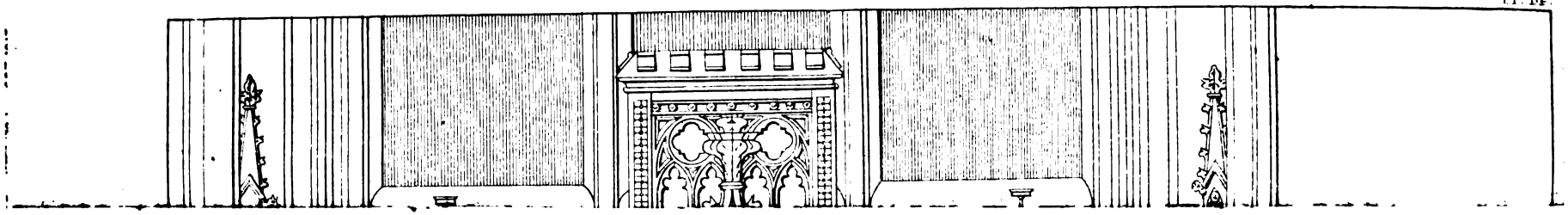
ELEVATION, PLAN & SECTION OF ALTAR AND REREDOS IN THE LEEMING CHANTRY, St JOHNS CATHEDRAL SALFORD

Pl. 14.



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THE IRON MANUFACTURE OF GREAT BRITAIN.*

In a late number of the *Journal* (Vol. XVIII., p. 319) we briefly noticed Mr. Truran's work on the 'Iron Manufacture of Great Britain,' and gave a sufficient indication of its contents to show that it enters fully into the whole process of manufacture, and considers theoretically, as well as practically, the causes that influence the yield of the ores and the quality of the iron. The subject is one of great interest and importance, and as this is the only practical treatise on the manufacture of iron that has appeared since Mushet's, we purpose to enter somewhat lengthily into its consideration. We shall in the first place point out some of the prominent facts as at present known, and then examine the theories which Mr. Truran announces and supports in opposition to those that have hitherto been generally received; more particularly as regards the application of the hot-blast and of the waste heat of furnaces.

The raw materials of manufacture are naturally first treated of. The iron ores which accompany the coal formation, vary in quality and richness according to their different positions among the seams of coal. It is from the argillaceous ores that the best quality of iron is at present manufactured. They abound most in the South Wales coal district, though they are to be found also in most others. The actual amount of clay mingled with them is not, however, so great as that of sand; and in some of the specimens the proportion of clay is so low as not to exceed one per cent. The analysis of one of the richest specimens presents—carbonate of iron, 77·1; silica, 15·9; aluminum, 3·8; the quantity of metallic iron being 37·2.

The carbonaceous ore, from which the Scotch iron-masters principally obtain their iron, is a comparatively recent discovery; "the black-band," in which it occurs, having been neglected till attention was drawn to its value by Mr. Mushet.

The calcareous iron ore occurs in the lower beds of the coal formation, resting upon, and being partially mingled with, the mountain limestone. The ore contains nearly a sufficiency of lime to serve as flux for its reduction in the furnace; it also presents great facilities for working, though it is not so rich as either of the former ores, nor is the iron obtained from it of the best quality. The red hematites of Lancashire and Cumberland are the richest ores of iron in this country, and Mr. Truran is of opinion that when a better method of working them has been discovered, they will prove to be the most valuable sources of supply. At present, however, they are only used when combined with other and leaner ores. The siliceous ores, of which extensive deposits have been recently discovered in Northamptonshire and Yorkshire, have not yet come into much use, and the quality of iron obtained from them is inferior; but the great facility with which the mines can be worked, and the large per centage of iron, lead to the belief that they will ere long be found valuable additions to our sources of supply.

In considering the raw materials of manufacture, the different qualities of the ores, the fuel and fluxes, with the processes of their reduction, Mr. Truran goes little beyond the view taken by a practical manager. He is eminently a practical and not a philosophical writer; and though he occasionally departs from the details of practice to enter the field of theory, it is rather for the purpose of showing the errors of theories that are not borne out by practical results, than for the object of advancing new theories of his own. The work is practical, indeed, within such a limited range that the *rationale* of the processes is scarcely considered, and little idea of the action is given to the general reader. The peculiar use of fluxes and of the cause of the extrication of the metal from the ore in the furnace, are not distinctly touched upon, and it would require original thought on the part of the reader to arrive at the conclusion that the appearance of the melted iron in the hearth is caused by the superior specific gravity of the metal, which, when the whole is in a fluid mass, enables it to percolate through and fall to the bottom. It is to be regretted that such notices of the causes of action are not more frequently interspersed, for though they may be so familiar to Mr. Truran as to appear unnecessary to mention, there is always advantage attending the repetition of causes.

The first process to which the iron ore is subjected is that of roasting, for the purpose of expelling the sulphur and other volatile contents. In the best iron works the operation is performed in kilns, constructed for the purpose, but the roasting is very frequently done in the open air. The latter method saves cost of construction, but is very imperfect in its operation, and Mr. Truran shows that in both fuel and labour there is a decided advantage in employing kilns. "The kiln system," he says, "is 6*d.* the ton cheaper than the open air. A 6*d.* in the ton in the cost of preparing an ore yielding 32 per cent. of iron, is equal to 1*s.* 7*d.* nearly on the ton of pig iron. Independently, however, of this sum, the effectual manner in which kilns perform the operation, enables the ore to be worked with a blast furnace with less fuel, and the resulting metal is of a better quality."

The construction of the blast-furnace and its appendages are minutely examined by Mr. Truran, who describes the different modes of charging the furnace with fuel, flux, and ore. The "blowing-in" is an operation of great nicety, and requires considerable time, and all attempts to shorten the process are said to have failed. This important operation, with the consequences attending undue haste, is thus described:—

"Everything having been arranged for its admission, blast is let into the tuyeres and the furnace 'blown-in.' At first, the tuyere pipes are of small diameter, but in this, as in too many other matters connected with the manufacture, no fixed rule exists, and a great difference in the size of the nozzles employed in blowing-in furnaces, at the same works, may be observed in practice. And yet with similar ores and fuels, smelted in furnaces of the same internal dimensions, the diameter of the first set of pipes should bear some proportion to those eventually adopted for a full blast. We have endeavoured to arrive at some fixed ratio, and from the dimensions of those employed in blowing-in eleven furnaces under our immediate observation, we find that the average area of the pipes through which blast is first delivered, is one-fifth of the area of the pipes ultimately employed. With this proportion, all risk of failure in the operation, and of subsequent injury to the furnace, will be avoided.

For a furnace of an internal capacity of 275 cubic yards, and intended to be blown with 4 inch nozzle pipes, the first set will be 1¾ inch bore. After blowing about 30 hours, these may be replaced by a set of 2¼ bore, increased at the expiration of three days to 2¾ inches. In ten days from the time of blowing-in, the bore may be altered to 3¼, and in three weeks to 3¾. Full size pipes may be used in four or five weeks after blowing-in.

Cokes are invariably used as the fuel in blowing-in coal and coke furnaces; but if raw coal is to be used in the subsequent operations, the substitution may be made in the first charges after blowing.

The burden of ore and limestone described, should be kept on unaltered for ten days, in which time the furnace will go from 400 to 450 charges. It may then be increased to 6 cwt. of calcined ore, and 2¼ cwt. of limestone to a similar weight of carbon; with this burden it will go about 400 charges the first week after alteration, increasing however to 650 or 700 in the third or fourth week. If the furnace is intended for forge iron, the alteration in the burden should not be made until it has worked successfully for three or four weeks on gray iron.

After the application of the blast, the attendant founders will commence clearing the hearth below the tuyeres for the reception of cinders. These will make their appearance in about 12 hours after blowing. In 24 hours they will have filled the hearth to a level with the notch in the dam-plate, and in three days will flow in quantities sufficient for their direction, through the troughs to the cinder tubs.

The metal will appear in about 10 hours after the cinders, and collect in the hearth to the amount of 3 or 3½ tons in 60 hours after blowing. In about 18 hours afterwards, another casting of about two tons may be made; from this time the operation of casting may be performed at the usual stated periods, once in 12 hours or oftener. The quantity of metal at each casting will increase from two tons the second cast, to about five tons in the fourth week. From the first week's blowing the produce of metal will be about 22 tons; from the second 38 tons; from the third 55 tons; while the fourth week's make will not fall short of 80 tons. With the burden stated, and a full blast, the produce will average 110 tons at the expiration of 10 or 12 weeks, but a greater weekly make than this cannot, under existing circumstances, be permanently obtained from that size furnace, working on lean argillaceous ores for foundry purposes.

Forcing the furnace, that a greater produce of iron may be obtained, is attended with the most injurious effects on its subsequent working. In the present day, the majority of furnaces put in blast are permanently injured by this forcing. The desire of making immediate returns outweigh all considerations regarding the certain destruction of the boshes and hearth. The blowing is accomplished with large pipes, and the furnace filled and worked with rich ores, or calcined ore, and forge and finery cinders. White forge iron and a dark scouring cinder are the inevitable results of this proceeding. The produce is considerable for a few weeks, then it diminishes, and great difficulty is experienced in maintaining the furnace in working order. Alterations are now made in the burden, the volume of blast is diminished, and the forcing system compulsorily suspended for a period, in order to remedy the evils which a more temperate proceeding would have avoided. If the altered mode

* 'The Iron Manufacture of Great Britain Theoretically and Practically considered.' By William Truran, C.E. London: Spon. 1855. Imperial 4to. pp. 176. 23 Plates.

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of working is persevered in for some weeks, the condition of the furnace is generally much improved, and, although irreparably injured, may continue in work for a considerable period. But more commonly the system is carried on till the boshes are entirely destroyed, the hearth nearly so, and the brickwork around the tuyeres and over the fall thinned to that extent, that their outsides are maintained at a red heat. The breast is generally one mass of red hot bricks, and through this and the tuyere stoppings the pent-up flame will frequently burst, showing that the interior work has been destroyed. The bricks indeed are clearly distinguishable in the cinders, and it is from the quantities raked out that we are enabled to determine the rate of destruction. The bottom of the hearth is repaired with fire-clay from the front, but there is no access to other portions of the hearth, or the boshes, while the furnace is in blast. This circumstance should be well considered, when it is proposed to force a new furnace to a large weekly make. Eventually the make of the furnace is greatly diminished, the crude iron produced is of the worst quality; the yield of fuel to the ton of crude iron increases in an inverse ratio to the quantity made, the yield of ore is also increased, and a dense black cinder flows sluggishly from the hearth. In a few weeks the increase of cost consequent on the increased yield of materials, and diminution of make, becomes so great, that blowing-out and refitting the interior work is adopted as the only available remedy.

A notable instance of this forcing system occurred in the last year at the Abersychan works. A furnace was blown-in with such volumes of blast and rich burden of materials, that a cast of several tons was obtained within 14 hours after applying blast. And the first week's blowing produced 200 tons, at which rate it continued for two or three weeks, when it rapidly diminished, falling so low as 19 tons for one week's make. From this deplorable state it was made to produce 26 tons, and after considerable delay, 100 tons; but with a large increase in the yield of materials over that at the other furnaces.

The admission of blast of a high density in large volumes of the blowing-in, must exercise a very prejudicial effect on the duration of the brickwork of the interior. If the volume is large--similar to that at the Abersychan furnace, where the melting temperature of pig iron was created, and pervaded the hearth in a few minutes—and a corresponding temperature to the materials within the boshes, the destruction of the hearth and boshes is inevitable. Brickwork cannot withstand a sudden accession of temperature like this. Stonework also will not continue sound. If the bricks are well manufactured, and carefully set, the high temperature of the ascending gases will loosen them from their beds, and the descending materials striking on the projecting part, they are displaced and descend with the current of materials to the hearth. This displacement of the work is accelerated if the materals smelted are of a rich quality, and there is a deficiency of flux. It is well known that the cinders ordinarily produced in a furnace will, on flowing over brickwork, give it a glaze which materially protects the work from the action of the metal. This glazing is successfully accomplished, where a small blast and suitable burden of materials are used; but with a large blast and rich burden, the cinders are of a hot scouring nature, containing a large per-centage of iron, and as the temperature of the work is kept too high for the operation it does not secure the protection of a cinder glaze, and is readily acted on by the crude iron. The corrosive action of the fluid metal on the unprotected brickwork is forciby shown in the rapid manner in which portions of the hearth in well regulated furnaces are destroyed. The face of work inside, at and below the level at which the metal stands before tapping, has to be renewed every six or eight days with fire-clay tightly rammed into the hollows. This repairing clay has not, from the few hours which elapse before it is covered with metal, had the necessary time to obtain a glaze from the cinder, and therefore is rapidly destroyed by the metal to be renewed under similar circumstances."

One of the most remarkable facts brought to notice by the operations of the blast-furnace, is the quantity of air required for the proper combustion of the fuel. As all the air is introduced at a known pressure through pipes of a given size, its quantity can be accurately ascertained. In the largest furnaces, where the quantity of solid materials, of ore, fuel, and flux, amounts to 883 tons in the course of a week, the consumption of atmospheric air alone amounts to 2318 tons—nearly three times the weight of the solid matter. This immense quantity of atmospheric air is resolved into nitrogen, carbonic acid, and carbonic oxide, according to the more or less perfect combustion of the fuel. Theoretically speaking, it should be converted, when coke fuel is employed, into nitrogen and carbonic acid alone; but this degree of perfection is not attainable in practice. The changes which occur in the descending charge, commence in the throat of the furnace. This change is greater when coal is used instead of coke, because there immediately commences, on the introduction of the coal, a distillation of its volatile constituents, which escape as carburetted hydrogen and carbonic oxide, and are inflamed when emitted into the air, and produce vivid combustion. This "waste heat" adds nothing to the effect of the furnace, the coal being converted into coke before its heat is actually available for the reduction of the ore. The effect of the application of heat is to convert the ore from a peroxide of iron into a magnetic oxide. The fusion of the ore and flux occurs at a height of from 8 to 10 inches above the blast-pipe or tuyere. There the metal, from its greater specific gravity, begins to fall to the bottom, freed more or less from the fluid which floats on the surface and protects it from the oxidising influence of the gas.

One of the peculiar notions of Mr. Truran—which, proceeding from so practical an authority, deserves serious consideration—is, that the hot blast does not produce the effects that have been generally attributed to it. The ordinary opinions respecting the advantages attending the introduction of the hot blast is, that it diminishes the immediate cooling effect of the introduction of a large quantity of air. It seems, indeed, natural to conclude that if the air be heated to a temperature of 800° before its admission into the incandescent mass, its subsequent combination and combustion must produce a greater amount of heat than if it enters at a temperature of 50°. For instance, as the temperature of the air must be raised before it can enter into chemical combination with the fuel, to impart a portion of that heat to the air before its introduction into the furnace, must, it should seem, diminish the quantity that would otherwise have to be absorbed from the incandescent fuel. The blast of a common pair of bellows on an open fire is sufficient to illustrate this. The hot cinders first exposed to the air are cooled to blackness, and it is not until the blast has penetrated among the heated mass that its full effect in stimulating combustion, is perceived. To produce chemical combination, it is necessary that the combining surfaces should be greatly expanded, and the preliminary expansion of the air by heat must be obtained either from the hot fuel in the furnace, or by previous heating. It seems clear, therefore, that if this preliminary heating can be given to the air before it is blown-in, there must be a smaller amount of heat absorbed from the working effect of the furnace. This view of the case, however, is altogether repudiated by Mr. Truran, who, though he attaches great value to the hot blast, attributes the effects to some other cause.

We will now present his view of the question, and shall endeavour to point out the errors into which we conceive he has fallen. Alluding to Mr. Mushet, Dr. Thompson, and other authorities who attribute the superiority of a heated as contrasted with a cold blast to its diminished abstraction of heat, he observes:—"This explanation, though generally adopted as correct, is manifestly very wide of the real cause. To maintain active combustion of the fuel, atmospheric air is required; every pound of carbon burnt with air to carbonic acid, evolves a definite amount of heat. The time occupied in the evolution of this heat will depend entirely on the rapidity with which the oxygen of the air can be brought in contact with the carbon. The temperature retained will be in an inverse ratio for the time occupied in the evolution of the heat. If, then, the requisite mechanical means are adopted, the highest temperature which it is possible under any circumstances to produce may be maintained in the hearth of a cold-blast furnace." In another part, however, it is admitted that, under certain circumstances, the admission of a cold blast produces what is called a "dark tuyere;" that is, the air admitted chills the incandescent fuel, and forms a circular dark tube in the mass until the air becomes sufficiently heated and expanded for vivid combustion. This fact of the dark tuyere, however, which might be considered conclusive, is otherwise explained by Mr. Truran. First, taking it for granted that an ample supply of air must be attended immediately with vivid combustion, he assumes that the cause of a dark tuyere must be owing to the want of a sufficient supply. Thus the air that comes immediately in contact with the fuel is, he conceives, not of equal density to that of the air at a short distance from the nozzle of the tuyere. It is admitted that the dark tuyere is a defect, and that with a hot blast it does not occur; but such are Mr. Truran's peculiar views on the subject, that he cannot perceive that the bright tuyere of the hot blast is attributable to any diminution of the chilling effect of a strong blast of air. Mr. Truran also seems to take an erroneous view of combustive action, in his statement that the combustion with a hot blast must be less active than with a cold one, because the quantity of heated and expanded air forced into combination with the fuel, must be less in proportion to that of the cold blast. It is quite true, indeed, that a quantity of air, heated to 800°, and therefore expanded to nearly double its ordinary volume, can only contain half the amount of oxygen, and that to produce an equal combustion of the fuel, the pressure of the hot blast must be increased; but Mr. Truran does not take into consideration that the cold air admitted must undergo heating

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and expansion, at the expense of the incandescent coke, before its combination with the fuel to produce combustion.

The effects of a hot blast have no doubt been much exaggerated, and the great reductions in the consumption of coal that have been ascribed to it, are attributable in a great degree to other improvements in smelting. At the Dowlais furnaces, for instance, in 1791, the ton of pig iron was made with the consumption of the following materials:—

	Ton.	Cwt.		Ton.	Cwt.
Coal for coking	6	6	Engine coal	1	15
Ironstone calcined.....	2	18	Limestone	1	8

Forty years afterwards, though still using the cold blast, the Dowlais furnaces were making 1 ton of foundry iron with the following consumption of materials:—

	Ton.	Cwt.		Ton.	Cwt.
Coal	2	16	Coal for kilns	0	6½
Engine coal	0	10½	Limestone	0	18

When, as Mr. Truran observes, these results were commonly obtained before the introduction of the hot blast, it may be fairly concluded that the immense saving in fuel that is now observed is due to other causes. Among those causes he mentions the use of carbonaceous ore, which melts at a low temperature; the improvement of enlarging the throat of the furnace; and the successful substitution of raw coal for coke. Among other exaggerated advantages of the hot blast, has been mentioned its power of rendering anthracite coal available in the furnace; but this Mr. Truran shows is not correct. Long before the introduction of the hot blast, anthracite coal had been extensively and successfully used in South Wales.

The advantages which Mr. Truran admits are derivable from the hot blast, are ascribed by him to the following causes:—First, to the caloric thrown into the furnace, along with the blast, enabling a corresponding quantity of coal to be withdrawn, with the proportionate reduction of the volume of the blast. These effects, he says, produce an augmentation of the make, but no saving of fuel. Second, to the reduced volume of blast, and the large portion of caloric which it carries into the furnace causing a diminished consumption of carbon in the upper parts.

His explanation of the augmentation of make is founded on the fact that any reduction in the burden of coal is followed by an increased make of iron, whether the blast employed be hot or cold; but a cold blast cannot be employed with a greatly reduced quantity of coal without deteriorating the quality of ore. From this connection of the make with the consumption of coal, Mr. Truran lays it down as an axiom, "that, within uncertain limits, the total consumption of coal is constant with the same blast, and that the make is really in an inverse ratio to the burden of the coal." He further observes on this subject:—

"If, then, by heating the blast, and thus conveying into the furnace a quantity of caloric available for reducing the ore, we are enabled to withdraw a portion of the coal burden, the make will be doubly augmented;—first, by as much as the reducing power of the additional caloric at bottom; secondly, by the reduced proportion of carbon in the burden of materials to the same volume of blast. Estimating the make of iron and yield of coal with the cold blast at 100 tons, and 40 cwt. respectively, and the saving of furnace coal and consumption of stoves at 5 cwt., the increase of make with a hot blast may easily be ascertained. In the first place, assuming that the heat evolved by the combustion of the 5 cwt. of stove coal possesses the same reducing power as an equal weight charged at top, the increase from this source will amount to 12½ per cent.: in the second place, from the reduced burden of coal charged at top, there is an increase of 14 per cent.; total 26½ per cent. This fairly represents the increase of make on the substitution of a hot for a cold blast; but of the increase it will be observed that 14 per cent. is owing to the reduced burden of coal; on a cold blast furnace this reduction would be followed by the same increase of make. Hence, the hot is superior to the cold, only in as much as the reducing power of the caloric thrown in with the blast.

But this slight superiority disappears altogether if the quality of the resulting metal is taken into consideration. We find that in melting the hematites, siliceous ores, and varieties of the argillaceous ore, any reduction in the quantity of coal is seen in a corresponding deficiency of carbon in the metal. This inferiority of hot blast smelted iron is easily explained. By throwing in caloric with the blast at bottom, a quantity of the coal previously required may be withdrawn from the burden, without impairing the rate of smelting; but as the hot blast conveys no carbon into the interior, the volume of gaseous carbon available for the deoxidation of the ore and carbonisation of the crude iron, is reduced in the same ratio as the burden of coal.

If the temperature of the blast be elevated to the melting point of the ore, the fuel may be withdrawn, with the exception of a quantity containing a sufficiency of carbon for the deoxidation of the ore. But with the withdrawal of the fuel, we are deprived of the carbonating medium, and the iron so obtained would be nearly void of carbon. Hence, for every degree that we elevate the temperature of the blast, a quantity of coal may be withdrawn from the burden; but the carbonisation of the metal is thereby lessened and the quality deteriorated."

Taking this practical view of the influence of the hot blast in smelting, Mr. Truran infers, that unless the ore itself be of a quality to supply the requisite carbon, the iron make must be of inferior quality. The carbonaceous ores of Scotland, and some of the argillaceous ores, contain this property so abundantly that the hot blast can be applied without injury to the resulting quality of the iron; but in all other cases, Mr. Truran contends, the effect of the hot blast must be prejudicial. It may seem, however, to be a curious anomaly in Mr. Truran's views respecting the limited advantages of the hot blast, that he is inclined to extend the principle far beyond the notions entertained by the original inventor. He conceives that certain ores, containing the requisite supply of carbon, might *very advantageously be reduced by a hot blast alone, without any fuel.* This suggestion, which derives peculiar force and consideration, coming from so practical an authority, is developed in the following extract:—

"If the entire burden of coal was withdrawn, they could be reduced into metallic iron of a high quality, by the employment of a blast, heated to their melting point. This from numerous observations we are inclined to fix at between 1300° and 1400°; and, owing to the peculiar manner in which the carbon is combined with the metal, the time required with other ores for communicating the carbonaceous principle is unnecessary, consequently the make of the furnaces may be largely augmented without injury to the quality of the iron. By withdrawing nearly the entire quantity of coal now used in smelting, and communicating the requisite caloric through the medium of the blast, the make may be augmented beyond anything attainable with the present system of smelting. It must be borne in mind that two-thirds of the present consumption of limestone is necessary for fluxing the earths combined with the coal. Under this mode of smelting these ores, the materials charged into the furnace for the production of a ton of crude iron will weigh 36 cwt.,—34 cwt. of ore, and 2 cwt. of limestone. Now 240 tons of iron in a week has been obtained from a medium size furnace, but this was accompanied with a consumption of more than 1000 tons of solid materials, and the production of 700 tons of liquid matter. With an equally large consumption of materials, composed of fusible carbonaceous ore, and a minimum dose of limestone, the make of iron would be nearly 600 tons weekly. Looking however, to the richness of this ore, its comparative freedom from earthy matter, and low melting temperature, we venture to predict, that the time is not distant when a weekly make of 800 to 1000 tons will be as common as 150 to 200 tons under the present system.

The proposal to smelt these ores without the employment of fuel in the furnace, may at first sight appear chimerical, but when the whole of the circumstances attending the present system of manufacture are taken into consideration, the intelligent smelter will see reason for questioning the policy of using the present large quantity of coal."

We have devoted considerable space to the development of Mr. Truran's views respecting the operation of the hot blast, because they are those of an eminently practical man, and present the subject in a new light. Though we cannot agree with him in the theory of the action of the hot air on the incandescent fuel, and must incline to the general opinion that the cold blast has a cooling influence, yet he shows that the effects attributable to the hot blast have been greatly exaggerated, and he explains very clearly the circumstances under which it may be advantageously used.

There is another branch of the subject that has of late years attracted great consideration from iron-masters, on which Mr. Truran's practical experience is brought to bear with great effect. It will have been seen that he is not inclined to receive with favour any innovation, and that it is not until a novelty has been tested advantageously on a working scale that he is disposed to adopt it. The utilisation of the gases that escape from blast-furnaces, has long been a favourite project in Belgium, and after encountering many objections, its apparent advantages at length induced some of the Welsh iron-masters to adopt it. We have seen the system carried out in the Ystalyfera works, where the gases that usually escape into the air and burn to waste with vivid combustion, are collected, and applied either to aid in heating the blast or to heat the boiler of the steam-engine. The system appears so economical that, after having seen its application, it seems strange, to an unpractical man, that it should not be generally adopted. Mr. Truran, however, after a thorough examination of the advantages of and objections to the system, proves, we think very conclusively, that the advantage to be

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gained does not compensate for the expense. In a properly managed blast-furnace, where coke is used for fuel, there should, in fact, be little or no escape of waste gases.

The important consideration of the circumstances that affect the qualities of iron has received due weight from Mr. Truran, who examines minutely the causes of the cold-short and the hot-short principle. He observes:—

"From the great variation in the qualities of the metal produced from the different classes of ores, we conclude that the quality is affected chiefly by the earthy matrix. The qualities of the fuel and flux employed also directly influence the quality of the metal. Where a particular earth predominates in the ore, the resulting crude metal will be alloyed chiefly with that earth; and we observe in Scotch pig iron smelted from the carbonaceous ores, that an excess of carbon in the operation is followed by the production of a highly carbonated metal, greatly deficient in strength and hardness. But the siliceous ores are the most difficult to manage. The silica combined with the metal is infusible at ordinary temperatures, and during the processes of manufacture in the forge and mill, it is incorporated in the bar to the manifest injury and deterioration of the metal for commercial purposes.

Iron ores having carbon, silica, lime, and alumina, in nearly equal portions, would smelt with the greatest facility, and produce metal of superior quality. The per-centage of metal being equal, the ore which contains these substances in the greatest uniformity is the most valuable. In the manufacture of malleable iron, this equality of the earthy basis is attended with the best results; for since the red and cold-short principles in bar iron are mainly owing to an excess of one or other of these earths, their presence in nearly equal portions would conduce to the production of metal free from such defects.

This property of the calcareous and siliceous ores of producing iron debased by the presence of an excess of lime in one case and silica in the other, is an effectual barrier to their being worked alone in the blast furnace, when the metal is intended for conversion into malleable iron of superior quality. And in the matter even of castings—except such as are for ornament or dead weight—these metals do not possess the requisite strength for machinery subject to vibration and working under great strain. The defects in metals from these ores are now well understood, and the smelter combines them with an equal or superior weight of argillaceous ores, in order to produce metal suitable for the forge. But the defects common to each ore will appear more or less apparent in the finished bar. If a siliceous ore has been used, the metal will be hard, and the cold-short principle developed in proportion to the quantity of ore used. If calcareous ores, the red short tendency of the metal will prevail in a similar ratio. By mixing all three, argillaceous, calcareous, and siliceous, the resulting metal will exhibit, in the manufactured bar, the defects incidental to an excess of the predominating earth of the mixture."

The consideration of the processes of refining crude iron, and of converting it into bars, forms no small part of Mr. Truran's work. These questions, however, are of so entirely a practical nature as not to come within the scope of our observations. In explaining the theory of the refining process, he states it to be a combined operation "of chemical and mechanical processes, whereby the metallic iron is deprived of a portion of the extraneous matter contracted in the blast-furnace." This we conceive to be scarcely a correct representation of the actual state of the fact. It is not owing to the contraction of extraneous matters by the metal in the furnace, but by the failure of the furnace to extract from it matter with which it was previously combined, that the crude state of the iron depends. In the refinery-furnace, the larger volume of the oxygen thrown in with the blast unites with the carbon of the fuel during the combustion, forming carbonic acid; an inferior volume unites with the carbon-vapour evolved from the molten iron, forming also carbonic acid; and a still smaller quantity of the oxygen unites with the alloys in the metal, forming silica, alumina, and other oxides.

During Mr. Truran's superintendence of the Dowlais works, he had not unfrequently to direct the management of new processes, and though averse to the introduction of innovations, he always gave well-considered projects fair consideration. Among the novelties attempted to be introduced in the refinery processes, was the admission of jets of steam into the puddling-furnace. The invention was considered, for a time, as a decided improvement, producing a superior quality and a larger quantity. After an extensive trial, however, it was discovered that the advantages realised in the large way were not commensurate with the expense of attending to, and the maintenance of, the steam apparatus.

The power expended in the various processes of the iron manufacture of Great Britain is enormous, and some approximation to a correct estimation of it has been attained by Mr. Truran. The following extract, with which we shall conclude our notice of this very valuable work, gives the data on which these calculations are founded:—

"An approximation to the gross engine power employed in the iron manufacture of this country, and the mining operations connected therewith, may be obtained by a reference to the power employed at the Dowlais works, where the crude iron produced by the blast furnaces is converted principally into rail iron and other heavy bars. The proportion of power to produce is considerably over that prevaling in Scotland, and the northern districts, but is under the power employed in Staffordshire and others largely manufacturing the smallest size bars; and may be considered as being near the mean of the districts.

The power delivered off by the Dowlais engines in the present year (1855) is nearly as follows:

		Horse Power.
4	Pumping engines, draining colliery and iron ore workings, and supplying works with surface water	496
16	Engines winding out of coal and iron ore pits.....	1134
14	Engines at inclined planes and secondary operations	668
11	Locomotive engines, hauling coal and ore to works, and produce to and from furnaces	580
2	Engines driving clay mills, pug mills, and brick moulding machines	76
5	Blowing engines	2154
10	Forge and mill engines	2165
2	Engines driving lathes, and shearing cold iron	35
	Total horse power	7308

The annual production of these works amounts to 108,567 tons of pig iron; the annual production of the United Kingdom 3,585,906 tons; calculated on the above power, the manufacture is conducted with engines of the collective power of 242,000 horses."

Since the publication of his work 'On the Iron Manufacture of Great Britain,' Mr. Truran has patented improvements in the construction of furnaces, and in the mode of applying the blast, which have for their object the attainment of very important results. The improvement in the construction of furnaces is an application of the principle, enforced in his work, of enlarging the space above the "boshes." In furnaces, as generally constructed, the throat is contracted so as frequently not to exceed one-quarter the diameter of the widest part. Such contraction is strongly condemned by Mr. Truran, since it produces an increased draught in the throat, and thus wastes the heating power of the fuel before it descends sufficiently low to do effectual work in smelting the iron. He attributes the former large consumption of fuel compared with the make of iron, to the contraction of the throat of the furnace, and he remarks, in confirmation of this opinion, that the more the throats of furnaces have been enlarged, the more economical has the working proved. The enlargement of that part of the furnace has hitherto been made in opposition to existing prejudices, though the advantage of it has been sufficiently experienced. In the construction patented by him, the space above the boshes is made at least equal to the diameter of any other part of the furnace. In the annexed engravings, fig. 1 represents a furnace as generally constructed, and fig. 2, one of Mr. Truran's patented forms.

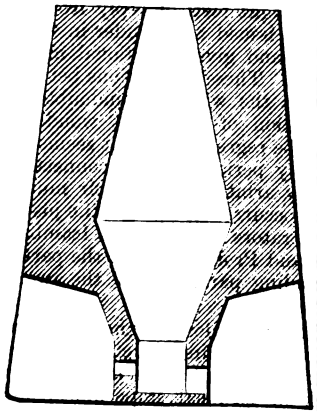

Fig. 1.

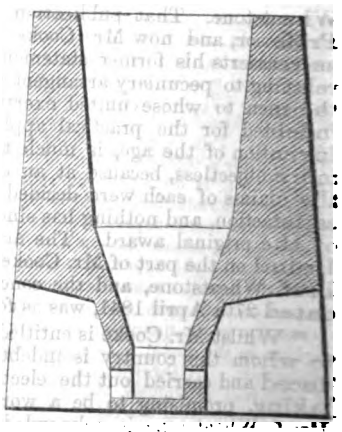

Fig. 2.

It is not, perhaps, to be expected that iron-masters will alter the blast-furnaces already constructed, even though they may be convinced of the advantage of the improved form, therefore it will

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be a long time before that part of Mr. Truran's invention is generally adopted; but the proposed modes of altering the blast may, without difficulty, be applied to any furnaces. This part of the invention consists in dividing the blast by the introduction of an inner tube in the nozzle. By that means an external annular blast of air is produced, which may be made of greater or less density than the central one, by varying the form of the internal tube. Thus, for instance, if it be required that the annular blast should be less compressed than the inner one, the form shown in fig. 3 is adopted; the expansion of the inner tube at B B, having the effect of contracting the area through which the air passes on the outside, thus causing a diminution of the pressure at the end of the nozzle. If, on the contrary, the annular blast is required to be stronger than the central one, the opposite form, represented in fig. 4, is adopted, where the inner tube is contracted at *c c*.

FIG. 3.

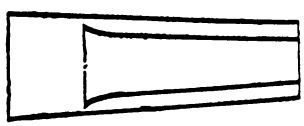
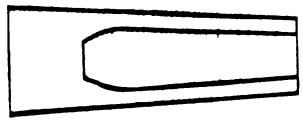


FIG. 4.



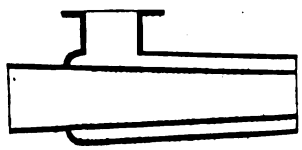


FIG. 5.

These are the simplest applications of the invention, and those which Mr. Truran prefers. When a variation of temperature between the inner and the outer annular blast is desired, that is effected by a distinct blast-pipe entering into and forming part of the nozzle, as shown in fig. 5. By these arrangements, Mr. Truran states he is able to smelt iron ores with greater economy of fuel, of blast, and of other materials; and that he can successfully smelt iron ores of every description with uncoked coal, and without previous calcination of the ores. He does not state in the specification of his patent the cause of the improved action of an annular blast, combined with a central one of different density; nor is it stated whether the best effects are produced when the central blast is more or less compressed than the outer one. We presume, however, that the improved effects are produced by surrounding the central blast with a tube of expanded air, which causes a more diffused combustion, and prevents the blast of highly compressed air from chilling the incandescent fuel. It may be considered, in short, as a self-creating hot-blast apparatus.

THE INVENTORS OF THE ELECTRIC TELEGRAPH.*

IN a former number of the *Journal*, we noticed a publication by Mr. W. F. Cooke, in vindication of his claim to be the inventor of the electric telegraph, in opposition to the claim of Prof. Wheatstone. That publication brought forth a reply from the Professor, and now Mr. Cooke has issued a rejoinder in which he reasserts his former statements, and gives additional matter relating to pecuniary arrangements. These contentions between the men to whose united exertions the world is, undoubtedly, indebted for the practical application of the most wonderful invention of the age, is much to be regretted; and it seems the more objectless, because at an early period of their connection, the claims of each were decided by arbitration, to their mutual satisfaction, and nothing has since occurred to disturb the justice of the original award. The arbitrators were Sir M. Isambard Brunel on the part of Mr. Cooke, and Prof. Daniel on the part of Prof. Wheatstone, and the concluding paragraph of the award, dated 27th April 1841, was as follows:

"Whilst Mr. Cooke is entitled to stand alone, as the gentleman to whom this country is indebted for having practically introduced and carried out the electric telegraph as a useful undertaking, promising to be a work of national importance; and Prof. Wheatstone is acknowledged as the scientific man whose profound and successful researches had already prepared the public to receive it as a project capable of practical application: it is to the united labours of the two gentlemen, so well qualified for mutual assistance, that we must attribute the rapid progress which the important invention has made during the five years since they have been associated."

By this award, the far larger share of the successful introduction of the electric telegraph is attributed to Mr. Cooke, and he might have rested satisfied with it; but he seems to have been goaded into a reassertion of his claims by some injudicious friends of Prof. Wheatstone, who continued to represent privately and in the press that nearly all the merit was due to the Professor, and that he had been in some manner unfairly deprived of the larger portion of the reward. In the present Reply by Mr. Cooke to Prof. Wheatstone's Answer, he endeavours to show that not only is he entitled to the honour of bringing the invention into practical operation, but that the arrangement of the instruments by which signals could be reciprocally transmitted between the distant stations, was contrived by him. In short, he claims to be the chief inventor of the apparatus, as well as the enterprising and indefatigable man of business by whose labours the invention was brought from the state of a philosophical toy to that of a most important agent in facilitating communication between distant places. The real question in dispute, however, is, not who invented the electric telegraph, for electro-telegraphic instruments had been invented years before either Prof. Wheatstone or Mr. Cooke thought of the matter,—but by whose agency was it brought into practical application? The arbitrators decided that question in favour of Mr. Cooke, though unquestionably the scientific researches and ingenious contrivances of Prof. Wheatstone, as well as his well-earned fame, contributed in no small degree to facilitate the introduction of the invention.

There is one point brought out more fully in this publication, which we are glad to see, as it removes the imputation of unfairness in the pecuniary transactions of Mr. Cooke with Prof. Wheatstone. There was a prevalent opinion that Prof. Wheatstone, after having taken the chief part in the invention, had not received his due share of reward; and that Mr. Cooke, whilst in partnership with the Professor, had contrived to appropriate the lion's share of the spoil. It appears, however, from Mr. Cooke's statement, that the partnership between them virtually ended in 1843, when Prof. Wheatstone entered into an arrangement to make over all his share in the patents on consideration of receiving a royalty per mile on all telegraph lines. Mr. Cooke subsequently undertook, at his own risk, in connection with another gentleman, to extend telegraph wires from London to Portsmouth; and it was to the successful result of that experiment that is mainly attributed the subsequent adoption of the electric telegraph, and the formation of the Electric Telegraph Company. Prof. Wheatstone was afterwards asked to name a price for his entire interest in the patents; he named 30,000*l.*, and that sum was paid him in cash. When the Electric Telegraph Company was formed, he was further offered the appointment of scientific adviser, with a salary of 700*l.*; but he took offence because other individuals, to whom he was personally hostile, were associated with the Company, and he withdrew. By Mr. Cooke's arrangement with the Electric Telegraph Company, he was to receive 96,066*l.*; of which 2566*l.* was to be paid in cash, 48,000*l.* out of profits, when made, and 45,500*l.* in shares of the Company on which only 25*l.* per share had been paid, so that he was liable to further calls of 136,500*l.* Mr. Cooke was also bound to serve the Company gratuitously for several years. The undertaking having proved successful, Mr. Cooke has received three times the amount paid to Prof. Wheatstone, at which the latter is annoyed; but he ought to bear in mind, that had the speculation not proved remunerative, he would have had cause to rejoice that he had obtained 30,000*l.* in cash for his share, free from risk. The total amount paid by the Company for the patent property was 150,000*l.*

Mr. Cooke endeavours to defend the Company from the charges of obstructing the progress of telegraphic invention, and of having purchased inventions for the purpose of suppressing them. Telegraphic inventors will not be inclined to agree with Mr. Cooke in this attempted vindication; and, indeed, he virtually admits the truth of such charges, in stating that the Company, being in possession of two systems of telegraph widely established, and "answering every practical purpose," have not been inclined to interrupt their business and waste their money by developing other systems. This is a repetition of the old stereotyped objection to the introduction of new improvements,

* 'The Electric Telegraph, was it Invented by Professor Wheatstone? A Reply to Professor Wheatstone's Answer.' By WILLIAM FOTHERGILL COOKE, Esq. London: Smith and Son. 1856.

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which prevented the electric telegraph from being an accomplished fact fifty years ago. It is, in effect, the reply given by the Admiralty to Mr. Ronalds in 1816:—"*Telegraphs are of no use in time of peace, and, during war*, THE SEMAPHORE ANSWERS EVERY PRACTICAL PURPOSE." We now are amazed at the stupidity of the Admiralty in 1816; less than fifty years hence, the world will be no less surprised by the same declaration of the practical inventor of the electric telegraph, that the present system "*answers every practical purpose*!"

RISE AND PROGRESS OF TRANS-ATLANTIC STEAM NAVIGATION.*

ON the 23rd of April 1838, a tremendous excitement prevailed in New York. "From an early hour until dark," we quote the language of this journal, "myriads of persons crowded the battery to have a glimpse of the first steam-vessel which had crossed the Atlantic from the British Isles and arrived safely in port; it is said that every Englishman in the city at one time or other during the day was gazing at the dark-looking vessel (the *Sirius*) with the American colours at the fore and the flag of Old England at the stern. The excitement was further increased by the arrival of the *Great Western* from Bristol, which left that port on the 7th instant, making the passage in fifteen days, thus solving the problem of possibility, and showing what can be done by enterprise, expenditure, courage, and skill. The *Sirius* is, however, the pioneer. It is a singular coincidence that both vessels should have arrived on St. George's day, the patron saint of the country to which they belong."

On the 31st of March of the same year, the London papers alluded to the experiment doubtfully. "There is really no mistake," said the *Times*, "in this long-talked-of project of navigating the Atlantic ocean by steam. There is no doubt of an intention to make the attempt, and to give the experiment, as such, a fair trial. The *Sirius* is absolutely getting under weigh for America."

Eighteen years will soon have elapsed since these doubts were uttered, and their solution thus enthusiastically recorded. What a change! We have fourteen lines of steamers actually running between the United States and Europe, comprising no fewer than 42 vessels!

Their rise and progress are curious. The *Sirius* and *Great Western* did not long enjoy a monopoly of the ocean ferry. They were quickly joined by the *Royal William* (which made a trip or two) the *City of Liverpool*, the *British Queen*, and *President*. Soon, the *Sirius* and *British Queen* were sold, the *President* went down, and their place was taken by a new line, got up by a combination of Scotchmen and Bluenoses—an astonishing set of people for enterprise. The new line was called the Cunard line, from the leading Bluenose, and launched four steamers—the *Acadia*, the *Caledonia*, the *Britannia*, and *Columbia*; they commenced to run about 1840, and ran from Boston and Halifax to Liverpool. In 1843, the *Columbia* was lost—the only vessel ever lost by the Cunard line; all the lives on board were saved.

Shortly after, a French line, consisting of four steamers, was established, but after a few trips it was abandoned. Then a Belgian line was organised, and also abandoned. Soon afterwards, the first American line of transatlantic steamers was inaugurated by the sailing of the *Washington* for Bremen. She was shortly after followed by the *Hermann*—both of which ships run still, with apparent success and profit. They were followed, at an interval of four or five years, by the Collins line, which launched successively the *Atlantic*, *Arctic*, *Baltic*, and *Pacific*, and are now building the *Adriatic* to take the place of the lost *Arctic*.

Latterly, several new lines have been established. The American-Havre line, which was started a few years ago, having lost its two vessels—the *Humboldt* and *Franklin*—replaced them by the *Arago* and *Fulton*. Glasgow started a line of screw steamers to New York, and another line on the same plan was shortly afterwards started between Liverpool and Philadelphia, without, however, competing with the Collins or Cunard lines. Quite recently a screw line, consisting of the *Minna* and *Brenda*, has been established to run between London, Cork, and New York; they will probably be called the Corkscrews. The Cunard Company has also begun to run a line between Havre and New York; a Belgian company has launched vessels to run from Antwerp, and the French are going to run vessels with warlike names from Havre on their own account.

Altogether we may sum up the ocean steam lines established between the United States and Europe in the following table:—

	Name.	Class.	Tonnage.
Liverpool and New York.			
Collins line	*Atlantic*	Paddle-wheel	3000
	Pacific	,,	3000
	Baltic	,,	3000
	Adriatic	,,	4200
Cunard line	*Persia*	,,	3600
	Africa	,,	2250
	Asia	,,	2260
	Europa	,,	2250
Liverpool and Boston.			
Cunard line	*America*	Paddle-wheel	1800
	Arabia	,,	2250
	Canada	,,	1800
	Niagara	,,	2250
Glasgow and New York.			
Scotch line	*Edinburgh*	Screw	2500
	New York	,,	2150
	Glasgow	,,	1962
London, Cork, and New York.			
Cork line	*Minna*	Screw	1300
	Brenda	,,	1300
New York and Havre.			
Cunard line	*Ætna*	Screw	3000
	Jura	,,	3000
	Emeu	,,	2000
	Lebanon	,,	2000
	Cambria	Paddle-wheel	1800
French line	*Alma*	Screw	1500
	Barcelone	,,	1500
	Sebastopol	,,	1500
Old Havre line	*Arago*	Paddle-wheel	2700
	Fulton	,,	2500
	Union	,,	2000
New Havre line	*Ariel*	,,	2000
	North Star	,,	2000
	Vanderbilt	,,	3600
Indian Havre line.	*Ericsson*	,,	1800
Antwerp, Southampton, and New York.			
Belgian line	*Belgique*	Screw	2500
	Constitution	,,	2500
	Leopold I.	,,	2500
	Duc de Brabant	,,	2500
	Congress	,,	2500
New York, Southampton, and Bremen.			
Bremen line	*Washington*	Paddle-wheel	2000
	Hermann	,,	2000
Liverpool and Philadelphia.			
Philadelphia line	*City of Baltimore*	Screw	2367
	City of Washington	,,	2382
	City of Manchester	,,	2109

In addition to the above, a line has been established between Portland and Liverpool, in which the *Sarah Sands* and *Canadian* run.

The disasters to ocean steamships may likewise be summed up as follows:—

President	Never heard of.
Columbia	All hands saved.
Humboldt	All hands saved.
City of Glasgow	Never heard of.
City of Philadelphia	All hands saved.
Franklin	All hands saved.
Arctic	A few only saved.

The bill of mortality is really very small when the total number of steamers afloat is considered. As science progresses, even this proportion will be lessened. We may hope that when we have a hundred steamers afloat we shall neither hear of lost vessels nor feel excited or anxious, with good reason, when a steamer is unduly delayed.

[The *Pacific* may now, it is feared, be added to the above list of disasters.]—ED.

* From the 'New York Herald.'

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SOUTH AUSTRALIA, AND ITS PUBLIC WORKS.

By W. Bennett Hays, C.E.

(*Concluded from p.* 116.)

River Murray Navigation.

The most important operations that have been as yet undertaken in the colony of South Australia, are certainly those in connection with the navigation of the river Murray. This river, which forms a notable exception to the general characteristics of the Australian continent in respect of its inland waters, has its source among the Australian Alps which lie near the south eastern coast of Australia, on the borders of the two colonies of New South Wales and Victoria; and, as it receives the drainage from the back or inland side of those mountains, it takes an inland course, at first in a west and north-west direction, forming the boundary-line between these two colonies; after which it enters that of South Australia, when its course becomes abruptly changed to one nearly due south, until it discharges its waters into the broad but shallow lake of Alexandrina or Victoria, through which it eventually reaches the ocean at Encounter bay on the south-west coast. It thus traverses, in a course of nearly 2000 miles, the entire south-eastern portion of the Australian continent, forming a water communication, whose future importance can scarcely be estimated, between the three principal settlements of this new world. It is also fed in its course by tributaries, some of which almost vie in extent and importance with the main stream. The principal of these are, the Darling, the Lachlan, and the Murrumbidgee, the former of which takes its rise in the vicinity of Moreton bay, and pursues a course of upwards of 1500 miles before it joins its waters with those of the Murray.

It was in tracing the course of the latter tributary in 1830, that Capt. Charles Sturt, of the 39th regiment, one of the most intrepid and indefatigable of the early explorers of the interior of Australia, came upon this noble river, which he named after the then colonial secretary, Sir George Murray. Sturt succeeded on that occasion, after much privation and hardship, and with no other means of transport than a whale boat and a small skiff, in exploring the Murray downwards to its mouth. This discovery, which led to a further exploration of the hitherto unknown country lying immediately to the north and south of the lower part of the river, was mainly instrumental towards the future colonisation of South Australia.

The Murray, which forms in its general features such a striking exception to all the other Australian rivers, yet partakes to a great extent of the peculiarities which characterise most of them in the final discharge of their waters.

The manner in which this river joins the ocean presents a marked contrast with that of most rivers in other parts of the world, which are generally found to gradually widen and deepen in their course, and terminate in a broad estuary.

It would appear, from an inspection of the map, that the Murray discharges itself into the broad expanse of lake Victoria; it would be more properly described as *passing through* this lake, which, with the exception of the channel which the river takes through it, is extremely shallow. After thus passing through the lake, the river takes a course round Hindmarsh island, which it separates from the main land, in a channel bearing the name of the Goolwa, or Lower Murray. The last six or eight miles of this channel is separated from the sea, to which it runs nearly parallel, only by a line of sand-hills less than a quarter of a mile in width. To the southward of this, and in the same direction, is a narrow strip of water called the Koorong, between 80 and 90 miles in length, running parallel with the coast and still only separated from it by a narrow barrier of sand-hills.

The position of these waters is calculated to convey the idea that the river Murray had been thus, as it were, coasting along this great distance in the vain attempt to find an outlet. This outlet of the accumulated waters of the vast river and its tributaries is at last discovered to be a mere gap in the narrow barrier, scarcely 200 yards wide, being actually less than the width which the river itself possesses at its junction with the Darling, a distance of nearly 600 miles from the sea. The union with the waters of the ocean seems after all to have been accomplished only by a sort of compromise, the understanding being that the river, during the time of its periodical flooding, should be permitted to excavate for itself a channel just sufficient for the passage of its waters, which seldom exceeds 15 feet in depth, while in the interim the ocean should be at full liberty to work away at the filling up of the same, which it never fails to punctually perform, generally managing, before the return of the freshes, to reduce the outlet to a depth of from 4 to 6 feet.

And, undoubtedly, imagining the possibility of a freak of nature permitting the cessation of the flow of land-waters only for a very few years, accumulations of sand, beaten up by the waves and drifted by the wind, would, in that short time, close the gap almost as effectually as though it had never been, and compel the river to work out for itself a new discharge. Some idea may thus be formed of the striking peculiarity of this feature of the noble river Murray, in which particular it is probably unique in the whole world.

The beach adjacent to the sea-mouth, for a great part of the extent of the sweep of the bay, is remarkably flat; so much so, that in heavy weather, the breakers extend uninterruptedly for nearly two miles from high-water mark. And in the calmest weather, there is always so much surf across the mouth, arising from the constant swell of the Southern ocean, that an attempt to enter the river is at all times hazardous. The only sailing vessel that ever entered from the sea was a little cutter of 30 tons, taken in in 1841, by Captain Pullen, who was executing a survey of that part of the coast;—she has never made her exit again.

The great difficulties to be encountered by a vessel under sail only, in attempting the entrance, arise from the fact that, at the season when there is sufficient depth of water, a strong current is always setting out; and a wind of sufficient force to enable a ship to stem this current would necesssarily bring a heavy surf, which, with the narrow and tortuous channel existing just outside the mouth, combine to render the attempt almost hopeless.

One or two of the small steamers now navigating the river have been since taken in; but the operation, even in this case, was one requiring great skill and caution, and that in the most favourable state of the weather. The testimony of those persons most capable of giving an opinion, is to the effect, that the sea-mouth of the Murray, though occasionally practicable for vessels of light draught, presents, in its present condition, difficulties and dangers such as forbid its being regarded as a channel for commercial traffic.

Anything like an extended series of really useful observations has never been made of this part of the navigation. The difficulties attending the execution of such will at once appear obvious. The available navigation of the river may be said, then, to commence at or near a point in the Lower Murray channel, called Goolwa. A tolerably correct survey has been made from this point upwards.

The following particulars are taken from the joint report of the Surveyor-General, Capt. A. H. Freeling, R.E., and the Collector of Customs, R. R. Torrens, Esq., dated December 4, 1850, who accompanied the Lieut.-Governor of South Australia, Sir H. E. F. Young, in an exploring expedition as far as the junction of the Darling:—"Winding round Hindmarsh island, it now flows with a gentle current in open reaches, about a mile in average width, through which the navigable channel is upwards of 300 yards wide, averaging 1½ fathom, and plainly indicated by the colour of the water. (The soundings given by Pullen averaging 6 to 32 feet.) The course is 17 miles, terminating at point Sturt. The lake Alexandrina opens out round point Sturt, from whence to point Pomond, the entrance to the Murray, the course is 35 miles. The soundings give 1½ fathom, with plenty of room; water occasionally brackish. From Pomond to Ngarto, 51 miles, the river flows in noble reaches, 4 to 5 miles long, a quarter of a mile in width, having a channel 200 to 300 yards, with an average of 3 fathoms, and in no place less than 1½ fathom at the lowest state of the water. The current, never exceeding 1½ mile per hour, is in some reaches nearly imperceptible.

"In this portion of the river there exist no objections, either in the way of shoals or sunken trees, requiring particular notice; and, as the prevailing wind is against the current, all circumstances, so far, are favourable to navigation, not only by steamers but by sailing vessels drawing under 6 feet water. From this point to Overland corner, 180 miles, the river becomes gradually more tortuous, diminishing its breadth to an average of 300 yards, yet preserving a 2-fathom channel, 100 yards wide; it flows with a current increased to an average of 1½ mile per hour past Moorundee, winding through a valley some 3 miles wide, shut in on either side by lofty cliffs.

"The channel in this part of the river cannot be described as

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obstructed, yet a careful look-out is necessary to avoid those sunken trees which, having fallen from the banks, lay immersed in the river close to its sides.

"From Overland corner to the Darling, 311 miles, the cliffs bounding the valley of the Murray gradually degrade into secondary banks; the course of the river becomes yet more tortuous, the stream narrowing to an average of 250 yards, with a 2-fathom channel of 50 yards, the current increasing to an average of 2 miles per hour. The danger from sunken timber is greater in this upper part of the river, but we found no place in which a steam vessel, drawing 5 feet with 25 feet beam, might not be brought through.

"The principal difficulties may be removed at an expense trifling compared with the utility of the work. Four places were observed where the sunken timber extended nearly across the river.

"Soundings were taken in the channel every fifteen minutes throughout the journey, and not less than 1½ fathom found, except in one place a quarter of a mile above Monruna, when 8 feet only was shown. Sand spits project three-parts across the river in many places; but in such cases deep water is invariably found near the opposite shore in a narrowed channel, with an increased current.

"Assuming the river, at the time of this visit, had risen 4 feet, which, by all accounts, is an ample allowance for its rise, there would remain a channel throughout of at least 4 feet in depth, at the lowest season of the year. A succession of several dry seasons might possibly reduce this depth slightly; but we think it may be assumed for all purposes of navigation, that there exists a channel at all times not less than 4 feet deep, from the Darling downwards. Plenty of wood for steam-boat fuel is obtainable on its banks throughout the course of this river.

"The channel is to be found generally near one or other bank. The trees which have fallen into the river are not so great obstacles to navigation as may at first appear; for when the river s low, and vessels, in order to keep in the deep channel, are obliged to approach the banks, these fallen trees are visible and can be avoided; on the other hand, when the river is high, and the trees covered with water, the centre of the stream may be kept, where there is no danger.

"The river commences rising about the month of August, causing the waters of the Darling, the Rufus, and the numerous creeks and branches, to run up. The rise of the river between September 25 and October 2, at the junction of the Rufus, was 10 inches. The flood-marks at the junction of the Darling showed a rise of river 11 feet above the water-level of the 29th September."

The subsidence of the waters commences about the month of February.

It is due to the zeal and farsightedness of Sir Henry Young, that the river Murray, for so many years overlooked by the colonists of this and the adjoining provinces, is at length beginning to be availed of as a means of internal communication. Impressed with the importance of this hitherto neglected stream, this officer in the year 1850 turned his attention to the introduction of measures for promoting its navigation. With this view he first made a personal inspection of 600 miles of the river, in an expedition undertaken in the months of September and October of that year, during which the information contained in the above extract was gained, together with statistics of the traffic that might be anticipated; according to which the total annual freights, in wool, tallow, and other produce brought down the river, was estimated at 8600 tons, with a return traffic of 2900 tons in stores of all kinds.

The great barrier to the successful navigation of this river lay, however, in the impracticable nature of its sea-mouth. Accordingly it became necessary to seek for some means of compensating this prime defect. A commission, which had been appointed by the Executive for this purpose, as well as for a general examination of the coast line of South Australia, with a view to ascertaining its extent of harbour accommodation, brought into notice a small natural harbour at Encounter bay, situated at a distance of about 12 miles to the west of the mouth, and to which the name of port Elliott has been given. The distance by land from this port to a convenient point on the navigable Goolwa channel is little more than 7 miles. It was therefore proposed to make port Elliott the outlet for the river traffic, by the formation of a line of railway connecting it with this point.

The sum of 21,000*l.* was appropriated from the Land Fund of the colony for effecting this object, together with some necessary improvements in the harbour itself.

This measure of Sir Henry Young encountered at first considerable opposition from the colonists, biassed, it would appear, by self-interested and partial views of what was calculated to promote in a high degree the future welfare of this colony in particular, as well as the neighbouring ones. But by a steady perseverance in the course which he had marked out for himself, and supported in his views by the home government, the Lieut.-Governor succeeded after a time in removing much of the prejudice that his scheme had met with; and in 1851, a premium of 4000*l.* was offered by the legislature for the first and second iron steam-boats of not less than 40-horse power, and not more than 2 feet draught of water, which should succeed in navigating the Murray, from the Goolwa to at least the junction of the Darling.

This encouraging offer produced no effect until the year 1853, when in the month of July, Capt. Francis Cadell navigated round from Sydney a small steamer, which he had built there for the purpose, of 40-horse power. Waiting a favourable opportunity, this little vessel was pushed through the sea-mouth, and, a boat of about 100 tons capacity, having been previously built at the Goolwa to act as a lighter, the first freight-bearing vessels that had ever navigated the waters of the Murray, took their departure from Goolwa on the 25th August, 1853. Gannewarra, above Swan-hill, a distance of 1400 miles from the sea, was reached without accident on the 23rd September.

The following are the dimensions of the steamer, named the *Lady Augusta*, in honour of Lady Young:—Extreme length on deck 105 feet; extreme length of keel, 98 ft. 6 in.; depth of hold, 5 ft. 6 in.; breadth of beam, 12 feet; on the cross guards, 21 feet. She is built altogether on the American principle and model, and cost about 5000*l.* The engines, made at Sydney, are of 20-horse power each. Her total tonnage, including engines, which weigh 30 tons, is 91 tons. Her beams and planking are of New Zealand pine, her timbers are of honeysuckle. She draws 3 feet water when full, and 2 ft. 4 in. when light, and possesses accommodation for sixteen first-class passengers, and half as many second-class.

Encouraged by the success of this undertaking, a company has since been formed for the navigation of the river, to which a Charter of Incorporation has been granted by the local legislature, whereby the liability of the shareholders is limited to double the amount of their shares. Thirteen vessels of all kinds, belonging to this company, are now navigating the Murray, consisting of four paddle steamers of from 40 to 50-horse power, four wooden barges of from 120 to 150 tons, four iron barges from 50 to 150 tons, and a sailing schooner of 100 tons burthen.

Port Elliott and Goolwa Railway, and Harbour Improvements.

The first survey for these, the principal operations in the Murray navigation scheme, was made in 1849-50, by Mr. R. T. Hill, Surveyor to the Harbour Commission, who reported thereon to the commissioners in March 1850. His estimate for a single line of railway, 7 miles in length, with gradients suitable for locomotives, but designed to be worked at first by horses; also wooden jetties at the two termini, with a small breakwater for sheltering that at port Elliott, and moorings at the latter harbour, amounted to 21,100*l.* The line of country is favourable, presenting easy gradients with very light earthworks.

Operations were not commenced until the beginning of 1851. At that time, the Harbour Commission was no longer in existence, and the engineer, Mr. Hill, who laid out the line, having left the colony, the author was called upon by the government to undertake the execution of these works.

Upon a careful examination of the line, together with the contemplated works, it was found that the sum which had been appropriated was much lower than what would allow of their being executed in so substantial a manner as might have been desirable. But, owing to the then unpopularity of the measure, the Lieut.-Governor was unwilling at that time to sanction any increased amount. This fact, together with the urgency for the early completion of the line, consequent on the government being in a manner pledged to its speedy performance, having already offered a premium for the river navigation, rendered it imperative to reject everything in the construction that would add needlessly to expense, or be a cause of delay in the completion.

The object to be gained was the speedy completion of such means of transit as the funds would allow of; it being judged expedient to leave to the future development of the resources

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which the opening of the line was calculated to promote, the means for remedying the want of substantiality in the first execution of the work.

The result has completely justified this view. Long before the line was finished, hundreds of acres of land in its vicinity which had been hitherto waste and uncultivated, were eagerly bought up, the price paid for which was sufficient to cover nearly the whole outlay upon the works themselves. Townships were laid out, and a busy and thriving population began to give life and activity to what was before an almost silent wilderness.

The traffic on the railway within the first year after it was opened, was nearly sufficient to pay its working expenses. The line was first opened throughout in May 1854, and the tonnage conveyed along it from that time to March 1855 was 2371 tons, in wheat, flour, stores, and different goods, besides 3780 bales of wool. The receipts during this period were 1000*l.* 11*s.* 7*d.* for goods, and 160*l.* 5*s.* for passengers and parcels. The line is worked by horses. The total cost of the working establishment, as provided in the colonial estimates for the year 1855, is 1622*l.* 4*s.* 6*d.* per annum, consisting of the following items:—

Superintendent	Salary	£300 0 0
Bookkeeper	do.	160 0 0
Two Warehousemen and one Breakaman, each 313 days, at 9*s.* 6*d.*		446 0 6
One Teamster (cottage and) 365 days, at 8*s.*		146 0 0
One Labourer, 313 days, at 8*s.*		125 4 0
Increase under Clerk's Salary Act		20 0 0
Incidental expenses		25 0 0
Materials and extra labour for maintenance of line		100 0 0
Forage for horses, repairs to harness, and sundries		300 0 0
Total		£1622 4 6

The execution of this little railway, which has the honour of being the first opened for traffic in the Australian colonies, has justified the assumption on which some lines have been undertaken in the old country, namely, that a railway will make its own traffic. It has done more than this, and more than any English railway could ever have the opportunity of doing; it has not only created traffic, but it has created population—has gathered in its immediate vicinity a thriving community, where was before but an aboriginal waste, and initiated the development of vast lines of internal water communication, whose limits at the present time can scarcely be estimated, but which cannot fail to give a powerful stimulus to the progress of civilisation over the whole of that immense area of country watered by the Murray and its tributaries.

Until the discovery of this navigable river, the occupation of country westward and northward of Sydney and Port Philip, found its limit when the expense of the long and difficult land carriage over the mountainous tracts to these ports became such as to make the settlers' employment cease to be profitable. Thus a large interior tract of country remained unoccupied, not because of any inherent deficiency in natural productiveness, but because of its practical inaccessibility. The opening of the Murray, by giving a western outlet to the sea, has become the means of removing this practical boundary to profitable enterprise, and has at once opened up a new and extensive area for colonisation.

Construction of Railway.

At the time of the commencement of this undertaking, there was in the colony no contractor possessing the means of carrying it out in its entirety. Accordingly the government became in a sense their own contractors, purchasing all the necessary materials and employing a staff of workmen under the control of a resident superintendent. This course, which necessarily involved a greater amount of labour and responsibility on those entrusted with the management of the undertaking, was yet found to possess many advantages. In executing for the first time a work of this nature in a new country, it was anticipated that, in many instances, a departure might be advantageously made from the routine established in a country very differently situated in respect of natural features and material progress. It was convenient, therefore, not to be bound by the strict terms of a pre-arranged contract, but to be able to make such modifications in the mode of carrying out the work as experience should from time to time suggest. For the same reason, a far greater economy could be secured than would have resulted had the whole been let to a contractor, who, to cover the risks attendant on a new work, and the fluctuation in price of labour and materials, must have allowed a considerable margin for profits. A satisfactory proof of this was afterwards given. When the work was considerably advanced, a contractor came forward and offered to complete the whole on certain terms. His offer, on examination, was rejected, because his prices were in general nearly 50 per cent. higher than those at which the work was being actually executed.

Orders were sent to England, through the Agent-General for H.M. Crown Colonies, for the rails, turntables, truck-wheels and axles, and such like materials as could only be procured there. Both the price of iron and freights were at the time favourable to the desired economy, rails being purchased at 5*l.* 1*s.* 3*d.* per ton, and shipped to Port Adelaide for 1*l.* But 2*l.* per ton had to be paid for re-shipping by a coasting vessel from Port Adelaide to Port Elliott, not more than two days' sail.

The weight of rails is 40 lb. to the yard, *fish-tail* section, as shown by the illustration (fig. 1). It was at first intended that the permanent way should be formed by screwing these rails to longitudinal bearers of sawn timber 8 inches by 6 inches, laid edgewise, the narrow face upwards, and supported by cross sleepers of rough timber placed at every 3 feet. On attempting to negotiate for the supply of the sawn timber, difficulties were met with; sawyers were scarce in the colony, and independent in proportion to the smallness of their number. The only way of procuring the required timber was to agree with these men, at a certain price, to go into the *Tiers*—the colonial term for forest country—and fell and saw, and with others for the hire of bullocks and timber wagons for carriage to the works. Little dependance could be placed on the constancy of either of these classes of men; this, and the difficulty and distance of the land carriage over trackless hills and woods, led to the abandonment of the use of longitudinals, with the exception of a few hundred yards of way at the terminal stations, where there would be greater wear and tear.

Fig. 1. Section of Railway—(Scale, 4 feet to 1 inch.)

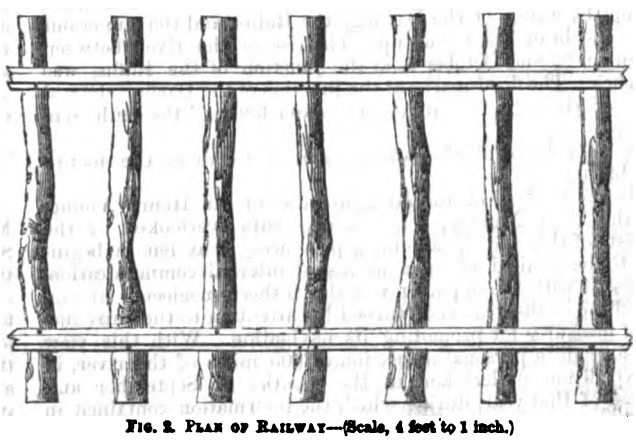

Fig. 2. Plan of Railway—(Scale, 4 feet to 1 inch.)

The price at first paid for sawing was 17*s.* per 100 feet, *colonial measurement*, a peculiar system, according to which the quantity is ascertained by multiplying together the dimensions of two sides of the sawn piece; thus in a scantling 8 by 6, 8 multiplied by 6 = 48, which divided by 12 is 4, this size is then said to contain four measurements; consequently 25 feet lineal would be 100 feet measurement. At this rate, 17*s.* per hundred would be about 2*s.* per cubic foot. The cost of cartage varies with the distance, but the average price per cubic foot delivered was from 2*s.* 6*d.* to 3*s.* The prime cost of the timber was an inconsiderable item, 5*l.* per annum only being paid for the license to cut any quantity on unsold land.

The prices afterwards advanced upwards of 50 per cent. in consequence of the rise in wages which followed the gold discoveries.

The permanent way thus constructed has been found to stand remarkably well, and has hitherto remained untouched by the white ant.

In laying the remainder of the line, transverse sleepers alone were used. Fig. 2 shows the permanent way thus constructed.

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The rails are screwed to the sleepers by ½-inch coach screws 5 inches long. The sleepers are of native wood, chiefly the eucalyptus, which is hard and durable and not readily attacked by the white ant, though not quite free from the ravages of this destructive insect. They are unhewn, being merely cross cut from the stems of small trees and the branches of larger ones, 8 feet long and averaging 7 inches diameter in the clear of the bark, which is stripped off. They are laid at distances of 2 feet from centre to centre, the largest being selected for the rail junctions. They are slightly adzed at the point where the rail lies upon them, to form a bed for it. The labour in cutting and delivering these sleepers was paid for by piece work; their average cost was rather less than 1s. each.

Workmen having experience in plate-laying could not be procured, but a few handy country carpenters were obtained, who soon became tolerably expert; one of whom, with a gang of labourers, could lay about 200 yards of permanent way in a week, at a cost of 1s. 9d per lineal yard, including trimming the sleepers.

The earthworks were very light, the country being favourable; the line generally nearly follows the surface. The ruling gradient of one in a hundred, adopted in the original survey, was increased to one in sixty-six for the sake of economy, and as being very well suited to animal traffic. The only cuttings of any consequence are two, situated near the two termini, one is about 170 yards long and 15 feet in the deepest part; the other, 370 yards and 29 feet at the deepest. The ground in both was easy for working; after cutting through 2 or 3 feet of the crust, which consists of the peculiar surface limestone described in a former part of this paper, the remainder was a compact sandy loam.

The earthworks were let piecework to gangs of labourers, the wagons and temporary rails and cattle being supplied them. The two deep cuttings were done at a cost of 1s. 3d. per cubic yard, the lead averaging a quarter of a mile.

The material used for ballast was the soft siliceous limestone, of which a sufficient quantity was got from the cuttings to supply the whole line. This was broken down small, and very soon became consolidated into a compact substance, in which the sleepers were imbedded, and which formed a firm and hard track for the horses. Common roads have been in some instances made with this material alone, which, as long as the traffic is light, is very durable, while, used for horse traffic alone (no wheels passing over it, and kept well drained), it will stand without sensible wear for years.

The line was not fenced: that was left to be done by the proprietors of lands adjoining the railway, the boundary line being defined by the side ditches. Although the line is laid single, sufficient width of land is taken for a double line.

There is one bridge to carry an accommodation road over the line across the cutting at the Port Elliott terminus. The other public roads cross on the level. No permanent water-courses cross the line, but several considerable waterways had to be left to carry off the land drainage in the wet season.

A commodious building for storing goods is erected at each terminus, together with workshops and a residence and office for the superintendent of the line. The line is laid double at the terminal stations, with turntables to connect them, and cross lines communicating with the stores. There are two intermediate sidings for passing places at about equal distances from the termini. The rolling stock consists of eleven goods trucks and one passenger carriage.

At the Goolwa terminus the rails are carried direct to the water's edge, where a small wharf front is built, affording space for one of the river boats or barges to lie alongside in 12 feet water, and provided with a crane. At the Port Elliott terminus the line is continued to the head of a wooden jetty running 100 feet into the harbour, with 6 feet of water at low tide, provided also with a crane. At this end there is also a weigh-bridge.

The rise of tide in the harbour is from 4 to 6 feet, but is extremely variable; sometimes in the winter season it will keep nearly up to the high-water mark for weeks together. The effect of the tide is scarcely felt in the lake, the height of water at Goolwa seldom varying so much as 2 feet.

Water Works.

In the immediate locality of the town of Port Elliott there is an absence of water, but at the base of a range of hills lying from one to two miles from the shore some good springs are found. The execution of works for the conveyance of this water to the town and harbour was therefore determined on, for the double purpose of supplying the shipping and the inhabitants. Levels were taken to a spot one mile distant from the harbour, where several small springs exist. Wells were sunk in three different places, to a depth of about 8 feet, and steined in dry brickwork. The water stood in all of them to the level of the surface. These wells were connected together by covered brick channels, puddled to keep out the surface water, which is slightly brackish. A spot was then selected on the high ground immediately overlooking the harbour, at the same level as the wells at the springs. Here a covered tank was built, 24 feet long, 8 feet wide and 8 feet deep, excavated in the ground and cased with brickwork, the bottom and sides being 9 inches thick, with two cross walls for supporting the sides, the whole laid in mortar. A foot of puddled clay is laid outside the brickwork, which makes the tank effectually water-tight, although the ground in which it is built is entirely sand. The top is covered with 4-inch gum planking, and 2 feet of earth laid over all. By this means the water is preserved at an agreeable temperature in all seasons.

The inhabitants draw their supply of water from the tank by means of a pump placed there for the purpose. An overflow pipe leads from the tank to the level of the railway below, conducting the superfluous water, which is always flowing in a stream, into an open trough for the use of horses and for general purposes.

The shipping is supplied by 2-inch cast-iron pipes leading from the tank to the jetty-head, whence the water is drawn by a hose pipe and stop-cock, direct into the ships' water-casks, which are brought alongside in boats.

Between the springs and the tank, a distance of one mile, the ground dips slightly, the greatest difference of level being about 20 feet. The water is conducted from the springs by a 4-inch pipe. Cast-iron piping not being procurable in the colony at a less price than 40*s.* per cwt., the necessary economy precluded its use, accordingly galvanised tinned iron was used. To compensate as much as possible for the want of durability in this material when laid underground, the pipe was carefully bedded throughout in fine concrete of a thickness of 4 inches all round it. Thus, should the pipe ultimately even entirely corrode away, a clear and indestructible channel would remain in the hardened concrete, the pressure from the head of water not being too great for this material to stand.

Owing to the general dearth of good spring water throughout the colony, particularly in the dry season, it is a common practice to have somewhat similar underground tanks to that here described attached to dwelling houses. The rain water collected from the roofs during the wet season, and stored in these tanks, furnishes a supply during the dry season for all purposes. Rain water so collected and stored, keeps very sweet and good, and is scarcely distinguishable in taste from good spring water.

The clearance and cultivation of the land in this country, although of so recent a date, appears to have already a remarkable effect in the development of permanent land water, where none before existed. In many localities, and particularly on the sloping foot of ranges of hills, numerous springs have from time to time burst forth, forming little perennial streams. A remarkable instance of this occurred during the summer of 1852-3. A new spring suddenly made its appearance not far those whence the water supply for Port Elliott is drawn; over a space of more than an acre the soil was slowly upheaved bodily to a height of about 5 feet above the surrounding level, from all parts of which water oozed out, standing in pools on the top and overflowing in a continuous stream.

Harbour Works.

Besides the jetty already mentioned, at Port Elliott, two moorings have been laid down in the harbour, capable of holding vessels of large size. These are placed under the lee of the small island called Lipson's breakwater. In this situation three or four vessels can ride in perfect safety in any weather, the island forming complete shelter against the south-west winds, which are the prevailing ones. This anchorage is open to the south-east; but little inconvenience is to be apprehended from a heavy sea from that quarter, on account of the shelter afforded by the sweep of the bay in that direction.

A heavy swell almost continually sets in from the south-west between Lipson's breakwater and Freeman's knob. The jetty, however, is well protected from this by the projecting headland

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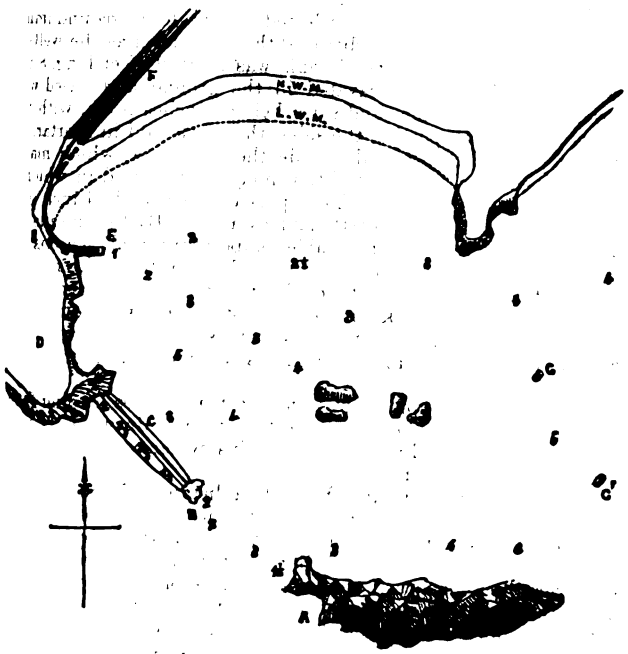
of the knob. Goods can be landed at it in almost all weathers; the practice is at present to do this by boats and lighters from the vessels which lie at the moorings. There is seldom sufficient surf in the harbour to prevent this being done.

The only work at present executed in the river, besides the small wharf at Goolwa, is the buoying out of the channel from that point across the lake to point Pomond where the Murray enters it.



PORT ELLIOTT HARBOUR.
A, Lipson's Breakwater.—B, Sunken Rock.—C, Breakwater.—D, Freeman's Nob. E, Jetty.—F, Port Elliott and Goolwa Railway.—G, G', Moorings.

Cost of Works.

The total cost of the whole of these works connected with the river Murray navigation, including engineering and superintendence, has been 31,000*l.*, of which the railway alone was a little less than 20,000*l.*, being at the rate of about 2857*l.* per mile. There were no parliamentary expenses whatever, and scarcely any for land, as the whole was crown land, with the exception of 12 or 14 acres which had to be purchased, at prices varying from 1*l.* to 2*l.* per acre.

Every circumstance that could tend to reduce the expense of this undertaking was availed of by the government. By executing the works in detail, contractors' profits were saved; the expense of superintendence was confined to the pay of one officer, which was at first four guineas a week, afterwards raised to 4*l.* 16*s.*: the engineering, management, and responsibility of the whole undertaking being borne by the Supervisor of Public Works, who receives a fixed salary in his capacity of head of the Public Works Department.

Port Elliott Breakwater.

Regarded as the sea outlet for the river Murray navigation, the harbour of port Elliott, though the best that nature had provided, is certainly, in its natural state, not all that could be desired.

The area and depth of water are doubtless sufficient for the accommodation of a large trade, could the whole of that area be made available. The most useful part of it, being that most accessible to the shore, is the portion lying between the jetty and the headland on the eastern side; but this is exposed to the constant set of the sea from the south-west through the opening between Freeman's knob and the island. Could this opening be closed, or even partially closed, the inner part of the harbour would be at once rendered available, and shipping might even lie alongside of wharves on its western side, where there would be direct communication with the railway.

Impressed with the importance of effecting some improvements in this harbour, the Executive in 1852 appropriated 10,000*l.* from the Land Fund for the commencement of a breakwater to be run out from Freeman's knob.

In the instructions which the author received for carrying out this work, it was directed that the most simple and inexpensive method of construction should be adopted, in order to effect as much as possible with the fund provided.

The headland being a mass of fine granite, rising abruptly from the sea to a height of upwards of 100 feet, it was at once determined that this material should be used. The depth of water across the opening varies from 1½ to 3 fathoms at low water, the rise of tide being about 5 feet. About midway there is a sunken rock barely visible at low water. The naval officer of the colony, Capt. Thomas Lipson, R.N., in reporting on this proposed work, recommended that it should be carried only as far as this rock, giving it as his opinion that sufficient shelter would thus be afforded to the harbour, because the swell entering beyond that point would be met by the detached rocks lying within the harbour. He considered it further desirable not to close the opening entirely, because, though vessels generally enter the harbour on its eastern side, it might be convenient sometimes to use this western entrance, there being 3 fathoms water in the middle of it.

The bottom is rocky, and is indeed a sort of reef, the water being deep outside and deepening again immediately within, as will be seen by the soundings.

The whole of this coast is at all times exposed to a very heavy swell; which, on meeting this reef, occasionally rises to something formidable, always breaking across it in heavy weather.

An accurate observation was once taken, during the progress of the works, of the height which a wave sometimes reaches at this place. The level line of the top of the breakwater being taken as a guide, the top of a wave was seen to rise 8 feet above the average water level. It is by no means certain that the trough of a sea is as much below the average level as the crest is above it, but on a moderate calculation the whole perpendicular lift of this wave could not have been less than from 13 to 14 feet.

SECTION OF BREAKWATER.

Any work to withstand this sea must necessarily be very substantial. The following simple method of construction was tried, and has been found perfectly successful. Granite was quarried in large blocks, and at once tipped, after the manner of a railway embankment, in the direction chosen for the work. The top of the breakwater is 21 feet wide and 5 feet above high-water mark. No attempt was made to give any particular slope to the sides, that which they assumed was about two horizontal to one vertical. It was anticipated that, by this method of formation, and by the use of very large blocks, the slope which they at first assumed would suffer no further alteration by the action of the sea; because, by the work being tipped at once to its full height, the lower stones were no sooner dropped than they were at once covered by those above them, being, in addition to their own intrinsic weight, thus held down by the superincumbent mass. The shape of the stones being very angular, they would become so interlocked that it would be scarcely possible for the sea to displace any of them, except perhaps those which lay exposed at the top.

A commencement was made of the work in April 1853. The stones, being quarried, were removed in wagons upon a line of rails laid down and continued along the top of the breakwater, as it progressed. In this manner a length of about 40 yards was first completed. Some little inconvenience was felt at times by the sea, which in bad weather broke quite over, disturbing the line of rails; but not sufficient to make it advisable to go to the expense of a raised staging.

This portion of the work was completed during the winter of 1853, and remained thus without any further additions during the ensuing winter. The exposure which it had during that time to many violent storms, gave satisfactory evidence of the correctness of the principle observed in its construction, not a single stone having been in any way disturbed.

The work was resumed in the summer of 1854, the same method of operations being pursued, but this time in a more

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systematic manner. A steam engine of six-horse power was first erected, with machinery for hoisting and moving the stones, also smiths' forges, with other conveniences for making and repairing tools; and a double line of rails was laid down upon the breakwater, with branches into the quarry. In a report to the government, dated November 17, 1854, the total cost of the breakwater to reach the midchannel rock, being a length of 211 yards, was estimated at 21,000*l.* This estimate was based on the following data.

Working Establishment.	£	s.	d.
30 Men blasting and quarrying, at per day 10*s.* ...	15	0	0
14 Men moving and tipping stones, at per day 9*s.* 6*d.* ...	6	13	0
4 Blacksmiths and Hammermen ...	4	16	0
1 Carpenter ...	0	14	0
1 Man and boy attending engine ...	1	0	0
1 Working Foreman ...	0	16	0
2 Boys, at per day 4*s.* ...	0	8	0
2 Boys, at per day 7*s.* 6*d.* ...	0	15	0
Powder, iron, coals, wood, rope, &c. ...	11	1	0
Total working expenditure, per day ...	£41	3	0

From previous experience it was reckoned that, with this establishment, an average of 72 cubic yards of stone per day could be deposited. The total quantity of stone in the breakwater when completed, would be 29,596 cubic yards; the quantity at this time remaining to be deposited was 28,028 cubic yards, consequently the estimated time required for completion was 389 working days, which, at the above daily rate of expenditure, would amount to ... £15,955 3 0

The outlay for plant was ...	2,323	3	10
For stone previously deposited ...	1,798	16	1
Allowance for contingencies ...	922	17	1
Estimated total ...	£21,000	0	0

This is equal to an average of 14*s.* 3*d.* per cubic yard of stone, measured in the breakwater, and of course including interstices.

At the beginning of February 1855, 97 lineal yards of the work was completed, at a cost somewhat *less* than had been estimated. At this time the work, though exposed to much heavy weather, had stood perfectly well.

The sizes of the blocks run about as follows: out of one hundred fifty contain from 60 to 90 cubic feet each; twenty-five from 30 to 60 cubic feet; and twenty-five smaller sizes.

A ton and a-half of powder was used to quarry 6300 cubic yards, or about 8½ ounces to a cubic yard, measured in the breakwater.

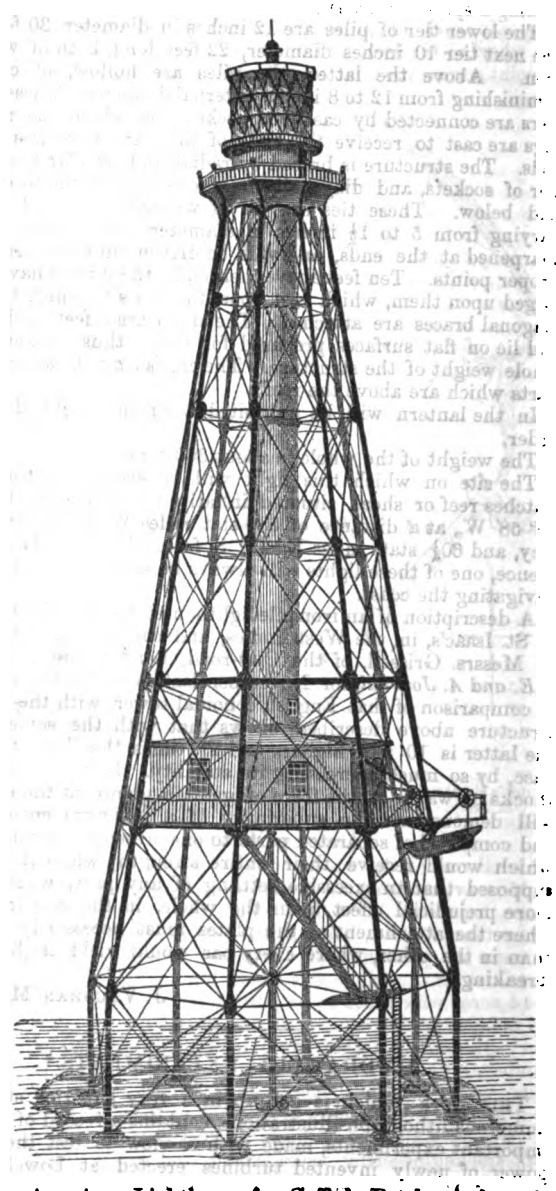
Costly as this work may appear when compared with English prices, there is no doubt it was done as cheaply as possible under the circumstances. A contractor, who was quite competent to the undertaking, made an offer to do the whole for 25*s.* per cubic yard, provided the government would incur the necessary outlay for plant. It is needless to say that this offer was not accepted.

Sand tamping was occasionally used in the blasting; it answered very well when the charge was fired by the galvanic battery, but with the patent fuse was apt to blow out.

The following method of blasting was found to answer very well in breaking up small blocks. A cartridge was made containing the requisite quantity of powder, having a small steel wire in the middle of it, with a percussion cap at each end, placed in such a manner that when in the hole, one cap rested on the bottom against the stone, and the other appeared at the top of the cartridge. To fire it, a rod of iron, fitting the hole accurately, was placed upon the cartridge; a sudden blow being given to this, by letting fall a hammer by means of a trigger, the percussion caps immediately exploded and ignited the powder. The blast acted well this way, splitting the stone, but in no case driving out the iron rod. *Two* percussion caps were used merely as a precaution in case one should miss fire.

Some experiments were made last month in Paris with a pair of Mr. Bakewell's copying telegraph instruments, which had been ordered by the French government for trial in that country, and were carried out on a line from Paris to Nantes, a distance of 300 miles, making the complete circuit to be traversed 600 miles. Through that distance autograph copies of writing, distinctly legible, were transmitted with great rapidity.

IRON PILE LIGHTHOUSE, COFFIN'S PATCHES REEF, FLORIDA.*



THE American Lighthouse for Coffin's Patches is intended to form a part of the splendid chain of lights along the dangerous coasts of the Florida reefs, which has, for some five years, been in course of erection by the U. S. government, and which, when completed, will be a lasting monument to a liberal and judicious policy in this department. It has been constructed under the superintendence of Lieut. George G. Meade, U.S. Topographical Engineers, assisted by Mr. John W. Nystrom, at the works of Merrick and Sons, Philadelphia. It will have the following general dimensions; height from bottom of piles to base of discs or top of rock 10 feet, from top of rock to high-water level at spring tides 10 feet; from high-water level to focal plane 137 feet; from top of rock to top of spire over lantern 164 ft. 9 in.; from top of rock to top of lantern 160 feet; diameter at the base and up to 10 feet above high-water level, 56 feet from centre to centre of piles. Diameter at the lantern or gallery floor 15 feet from centre to centre of piles; diameter of lantern (which is of boiler plate, for a height of 8 feet up to the upper gallery), 12 ft. 6 in.; thence glazed with thick French plate glass, same diameter as below (12 ft. 6 in.), 9 feet high, terminating in a conical top ventilator, and spire. The floor of the keeper's house is elevated 32 feet above high-water; and the house itself is of boiler plate

* From the 'Journal of the Franklin Institute.'

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lined with wood, 30 feet square by 10 feet in height. From this house, access is had to the lantern by a cylindrical boiler plate trunk 6½ feet diameter, surrounding the central pile, and containing a spiral staircase.

The lower tier of piles are 12 inches in diameter, 30 feet long, the next tier 10 inches diameter, 22 feet long, both of wrought-iron. Above the latter, the piles are hollow, of cast-iron, diminishing from 12 to 8 inches external diameter. These several tiers are connected by cast-iron sockets, on which the requisite lugs are cast to receive the ends of the various braces and tie rods. The structure is braced by radial and circular ties at each tier of sockets, and diagonally from one tier to the next above and below. These ties are all of wrought-iron and of sizes varying from 5 to 1½ inches in diameter. The lower piles are sharpened at the ends, and will be driven into the reef at the proper points. Ten feet above their ends, these piles have collars forged upon them, which rest upon the discs to which the lower diagonal braces are attached. The discs are 8 feet in diameter, and lie on flat surfaces prepared for them, thus supporting the whole weight of the structure. The engraving shows only those parts which are above the reef.

In the lantern will be exhibited a Fresnel light of the first order.

The weight of the whole is about 300 tons.

The site on which this light will be erected, is the Coffin's Patches reef or shoal, situated in latitude 24° 41½′ N., longitude 80° 58′ W., at a distance of 58½ stat. miles W. 15° N. from Sand Key, and 60½ stat. miles E. 42° S. from Carysfort Lighthouse. Hence, one of these lights will always be kept in sight by vessels navigating the coast.

A description of an iron pile lighthouse, destined for the island of St. Isaac's, in the West Indies, and constructed at the works of Messrs. Grissell, of the City-road, London, appeared in the *C.E. and A. Journal*, for November last (Vol. XVIII. page 375). A comparison of that English conoidal tower, with the columnar structure above described, shows that with the same weight, the latter is 10 feet higher, and 2½ times the diameter at the base, by so much increasing its stability. In withstanding the shocks of waves or the force of gales, a glance at the engraving will demonstrate the superiority of a structure entirely open and composed of separated parts, to one presenting a solid surface which would receive their entire strength; while it might be supposed that an excessive settling of any part, would have a more prejudicial effect upon the whole, in the cast-iron tower where the attachment of the plates must necessarily be rigid, than in the other, where every bar would yield slightly before breaking.

J. VAUGHAN MERRICK.

HYDRAULIC EXPERIMENTS.*

THIS work, which is got up in a very superior style, with numerous lithograph illustrations, contains a record of numerou important experiments, made with a view to test the working power of newly invented turbines erected at Lowell, in the state of Massachusetts; and further, to ascertain, by original investigation, the flow of water over weirs and canals. The vast amount of water-power in the United States makes the consideration of its economical application of less importance than in England; nevertheless, there have been nearly 200 patents obtained there for improvements in water-wheels of different constructions, and the degree of perfection attained greatly surpasses that reached in this country, if we may rely on these experiments, which were made by Mr. Francis with great care to arrive at accurate results. The turbines on which the experiments were principally made, were constructed by Mr. Bryden for the Appleton Company at Lowell. It formed an essential part of the contract between him and the company, that the amount to be paid should depend on the effective work of the machines. Seventy-eight per cent of the power of the water employed was taken as the standard, it being agreed, that if the turbines performed that amount of duty, the company were to to pay the patentee $1200, and $400 additional for every 1 per cent. of power obtained above 78. Two of the turbines were tested for the purpose, a Prony dynamometer being used to measure the useful effects, and a weir to guage the quantity of water expended. The result showed the useful effects to be 88 per cent., or 10 per cent. greater than the mean agreed on; and this result was so satisfactorily proved to the company, that they paid Mr. Bryden $5200 for the privilege to use his invention. The turbines have been in operation eight years, and they have continued to act very satisfactorily.

The principal points of difference between these water-wheels and those of Fourneyron, which are used in France, are stated to be as follows:—The wooden *flume*, which conducts the water to the turbine, is of the shape of an inverted truncated cone, so that the water, as it descends, has a gradually increasing velocity and a spiral motion, derived from the velocity with which the water enters the cone. The motion of the water is so arranged, it is supposed there would be no loss of power beyond the friction of the water against the sides of the curves. In the next place, the leading curves are not perpendicular, but are a little inclined backwards from the direction of the motion of the wheel, so that, the water descending with a spiral motion, meets only the edges of the guides. On the outside of the wheel there is an apparatus called a diffuser, the object of which is to convert into useful effect a part of the power which would otherwise be entirely lost, in consequence of the water leaving the wheel with considerable velocity. This apparatus, as described by Mr. Francis, "consists essentially of two stationary rings or discs, placed concentrically with the wheel, having an interior diameter a very little larger than the exterior diameter of the wheel; and an exterior diameter about equal to twice that of the wheel. The height between the discs, at their interior circumference, is a very little greater than that of the orifices in the exterior circumference of the wheel; and at the exterior circumference of the discs, the height between them is about twice as great as at the interior circumference. The form of the surfaces connecting the interior and exterior circumferences of the discs is gently rounded, the first elements of the curves near the interior circumferences being nearly horizontal. There is, consequently, included between the two surfaces, an aperture, gradually enlarging from the exterior circumference of the wheel to the exterior circumference of the diffuser. When the regulating gate is raised to its full height, the section through which the water passes will be increased by insensible degrees in the proportion of one to four, and if the velocity is uniform in all parts of the diffuser, at the same distance from the wheel, the velocity of the water will be diminished in the same proportion; or its velocity, on leaving the diffuser, will be one-fourth of that at its entrance. By the doctrine of living forces, the power of the water, in passing through the diffuser, must therefore be diminished to one-sixteenth of the power on its entrance. It is essential to the proper action of the diffuser that it should be entirely under water, and the power rendered useful by it is expended in diminishing the pressure against the water issuing from the exterior orifices of the wheel; and the effect produced is the same as if the available fall under which the turbine is acting, is increased a certain amount."... "The action of the diffuser depends upon similar principles to that of diverging conical tubes, which, when of certain proportions, it is well known, increase the discharge." The experiments with the turbine, when used with and without the diffuser, proved its utility by showing a gain of power equal to 3 per cent. Another peculiarity in the structure of this water-wheel, is its suspension from the top of the vertical shaft instead of running on a step at the bottom. This has been effected by cutting the upper part of the shaft into a series of collars, that work on corresponding projections in a box at the top.

During the experiments, various lubricating fluids were tried, but there was little difference in the effect, whether oils or water alone were applied. The results of the experiments, as expressed in a tabular form, are not very clearly stated, and great variations are represented to have occurred without any apparent cause. It would have been very desirable that a series of experiments should have been made with the express object of ascertaining the ratio of power due to different velocities, but this does not seem to have been done; and, as the conditions of the experiments are more or less varied, it is uncertain how far the results are due to variations in the velocities, or to other changes in the condition of the experiment. In none of the results given in the tables does the ratio of useful effect to the power expended, reach 80 per cent., the highest ratio given by turbine at the Tremont mills being 0·78375, the number of revolutions in a second being at the same time 0·831, and the fall of water acting

* 'Lowell Hydraulic Experiments, being a Selection from Experiments on Hydraulic Motors, on the Flow of Water over Weirs, and in Canals of Uniform Rectangular Section and of Short Length.' Made at Lowell, Massachusetts, by James B. Francis, C.E. Boston; Little, Brown and Co. 1855.

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upon the wheel 12·69 feet. With greater velocity, under nearly equal conditions in other respects, the ratio of power was not so high. The greatest rapidity with which the wheel rotated was one second and a-half per minute, at which velocity the ratio of useful effect is stated to have been only 0·345.

These elaborate and apparently very accurately conducted experiments, to ascertain the useful effect of the improved American turbine, will tend to direct more attention to that peculiar application of water power; and the experiments on the flow of water over weirs, also, afford considerable information on the imperfectly known actions of moving fluids. The author has endeavoured to avoid repeating the opinions of others, and this contribution to hydraulic science is consequently the more valuable from its being the result of original investigation.

ST. MARGARET'S CHURCH-YARD, WESTMINSTER.

In reverting to the subject of St. Margaret's Church-yard, we observe, with feelings of much regret, that the witty and facetious letters of "Resurgam," in the *Times*, have failed to put a stop to the abominations which have been already, in a great measure, perpetrated; for the church-yard in question has actually been paved with tomb-stones, in some parts "put together with a mosaic of odds and ends of Yorkshire flag," and in others the vacuities are filled up with coarse yellow gravel—considered, we presume, in admirable contrast with the more sober gravity of the York stone.

If this act of vandalism, bad taste, jobbery, or whatever it may be called, has been done on the score of economy, the parish authorities must have made a sad blunder, for it would have been a much more profitable speculation if they had either sold the stones by auction, or disposed of them to the Westminster Paving Commissioners, and then covered the ground with turf, interspersed with gravel walks. Whilst they were about it, they might also have cleared away the iron-railing from the Abbey, and thrown the whole into one plot, surrounding the same with a dwarf wall in taste and keeping with the style of the buildings to which it is attached.

Again, during the progress of these injudicious proceedings, an excellent opportunity has been thrown away of making the very important improvement at the western end of the church-yard. It has been observed, by persons acquainted with the locality, that the roadway at the acute angle of the church-yard, next to the Westminster hospital, is much too narrow for the greatly increased traffic along Victoria street, which, as a matter of course, will be found more inconvenient when the street is completely finished and occupied. If a strip were taken off the north-western end of the church-yard (which at present could be very easily accomplished), two objects would be gained, one of which will in time be felt as an absolute necessity; namely, the widening of the road, and by the other we should have an uninterrupted view, in nearly a straight line, along the whole range of Victoria street, which would afford a most magnificent perspective vista.

In our attempts to improve the church-yard, we should go a step further, and taking a little of the advice which "Resurgam" gives to the "Senior Churchwarden," should apply for an Act of Parliament—for what?—(we trust the rector and his vestrymen and churchwardens will not be alarmed)—why, to pull down St. Margaret's church also; for most assuredly it is, in the first place, one of the most superlatively ugly ecclesiastical edifices in all Westminster, and only disgraces some of the ornate and magnificent buildings by which it is surrounded, the effect of which it completely spoils. Secondly, if this abominable Batty-Langley-looking piece of Gothic lumber were removed, we should have an uninterrupted view of the whole northern side of Westminster Abbey and Henry VII.'s chapel; and when the law-courts are cleared away, we shall also have a perfect prospect of the north-western side of the Houses of Parliament from Westminster-bridge, including the Victoria tower, comprehending the whole range of that immense pile, which, in conjunction with the old Abbey, forms a group the compeer of which is rarely to be met with, either at home or abroad.

REVIEW OF NEW INVENTIONS.

The many inventions that are now patented, for improvements connected with architecture and engineering, make it difficult for those who do not pay special attention to the subject, to become acquainted with what has been attempted and accomplished. We propose, with a view of placing our readers *au courant* with the progress of invention in those matters most interesting to them, to give notices in the *Journal* of the specifications of such patents, with observations on the advantages they are likely to realise.

Compound Beams.

The first specification that presents itself within the last month, is that of Mr. Robert M'Connel, of Glasgow, ironfounder, for "improvements in beams or girders for structural purposes." Mr. M'Connel constructs his beam of two broad bars or plates of malleable iron, placed one above the other, but separated by short blocks of wood bolted to the plates, and having small spaces between them for the reception of the flooring joists. The blocks are disposed with the fibres of the wood in a vertical position, in which direction it has little or no perceptible shrinkage.

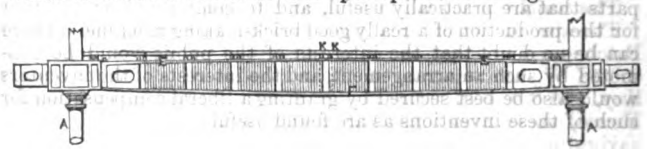

Fig. 1 is an elevation of a beam of this construction, supported at each end on cast-iron columns A A. The letters E, F, indicate the plates of iron at the top and bottom, and the intermediate shaded parts are the blocks of wood. The beam is bound into a compact mass by bolts passed from one plate of iron to the other.

In other arrangments the blocks are composed of cast-iron, and it is stated that one of the bars may be of cast-iron also. This compound girder, it is said, "combines superior strength with lightness and economy in materials and workmanship." It seems very questionable, however, whether a beam of this structure would possess more strength than is due to the two plates of iron that hold it together. The interposed blocks of wood may increase the rigidity of the iron, but it is very doubtful whether they would add to its strength. In the intermediate spaces, the pressure would bear solely on the plates of iron at the top and bottom, for the separating blocks are not made to interlock, so as to distribute the weight over a larger surface. In this respect the invention is bad in principle, and it presents an appearance of strength without the reality.

Brick-Making Machines.

The making of bricks is one of the matters in which inventors seem to run riot. The very many patents taken out for brick-making, show the want of some supervision in the Patent Office, for the purpose of preventing multiplicity of monopolies being granted for the same thing. In the Great Exhibition of 1851, there were five or six brick-making machines shown in operation, each of which so closely resembled the other that it required nice discrimination to detect the difference. Since that time there has been a constant flow of patents for accomplishing the same object, and now, within a month of each other, specifications have been published of four other patents for improved methods of brick-making. Mr. Joseph Eccles, of Blackburn, has patented various arrangements and mechanisms, which commence their operations by digging clay out of the bank for the purpose of manufacturing it into bricks. By subsequent arrangements, the waste heat from the boiler of the steam-engine is applied to dry the bricks after they have been made; and by a third arrangement, the waste heat of one brick-kiln is applied to heat another.

Mr. William Woodcock, of Hulme, Manchester, has obtained a patent for the application of an inclined trough to those machines for making bricks in which a circular horizontal table is employed, and for combining with the trough "sliding dampers," for regulating the quantity of clay to be supplied to the moulds.

Another invention, by Mr. William Williams, of Bedford, is described in the specification to relate "to the making of clay

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socket-pipes, by causing a mould of the form of the interior of the socket to be pressed up against the button of the die-plate, when the clay commences to be expressed by the motion of the piston; so that the tube, on coming out through the die-plate, comes against this mould, and is expanded to the form of the interior of the socket; the exterior form of the socket being given by a projection of a suitable shape from the face of the die-plate."

A fourth patent, granted to Mr. William Pearce, of Poole, Dorsetshire, though it includes hollow bricks as one of the articles of manufacture, is chiefly applicable to the making of pipes. The object is to adjust the core of the die or mould, in such a manner as to prevent the clay from being divided as it is forced through by the cross-bars usually employed to keep the core in its place. To effect this object, the core is supported by a central shaft so that the clay is pressed through the mould without being divided. By the same means any form of pipe or brick may be made with an internal cavity of any shape that may be required.

The latter invention promises to be the most useful of these additions to the catalogue of brick-making machines, though we incline to believe that the same object has been previously accomplished. It is most desirable that the multiplicity of inventions for making bricks should be carefully examined by some skilful and intelligent manufacturer, with a view to select from the mass the parts that are practically useful, and to combine them together for the production of a really good brick-making machine. There can be no doubt that the interests of the public would be promoted by such an arrangement, and the interests of the inventors would also be best secured by granting a liberal compensation for such of these inventions as are found useful.

Smelting Iron Ores.

Mr. Isaac Rogers, of the State of New York, has specified an invention for "improvements in the mode of treating iron ores." This invention consists in the use of a revolving deoxidising cylinder, heated in a reverberatory furnace, into which cylinder the ore, pulverised and mixed with charcoal, is introduced through a hollow journal at one end of the cylinder. As the cylinder revolves, the ore and charcoal are passed gradually by means of a helical screw from one end of the cylinder to the other; and the ore, after having been thus mingled intimately with the charcoal at a high temperature, is dropped into the smelting furnace. The object proposed to be attained by this contrivance is to deoxodise the ore, and to render it carbonaceous, by which means it is more readily melted. The apparatus is of too complicated a character for adoption on a large scale, even assuming it to produce the good results which the patentee asserts; and we conceive that the invention will be found only fitted for laboratory experiments.

Railway Wheels.

Mr. Samuel Ludbrook, of Mile End, manufacturer, has taken out a patent for railway wheels made with wooden peripheries. The same principle has frequently been attempted to be applied; and whether this application be essentially different from others, may be a question for the decision of lawyers, should the invention prove lucrative. In Mr. Ludbrook's specification it is stated that the invention consists in forming the outside edge of railway wheels of wood, forced and pressed into and between suitable holding plates and chambers, in such manner as to form a very hard and compact surface, with the grain of the wood so placed as to be at right angles to the surface of the rail at the point where the edge of the wheel comes in contact with it. The body of the wheel consists of a boss or nave cast with radial arms, the spaces between which are filled up with hard wood, forced in. A circular side-plate of iron is afterwards placed on each side, and the plates bolted firmly together; one of the side-plates being of larger diameter than the other, to form the flange of the wheel. Wedges of hard wood are then driven into the wooden part of the wheel, and afterwards turned down to a smooth surface. The hold that the wedges have on the wheel depends altogether on the pressure of the wood into which they are driven, consequently it is to be feared that the jarring of the wheels on the rails in dry weather would loosen the wedges, and that they would be thrown out by what is termed "centrifugal" action.

Smoke-Consuming Furnace.

Of the many inventions that have been patented for furnaces that consume their own smoke, there are few that can compare with that of Mr. John Cornes, of Swan-lane, in the city of London. It is not, however, for its superior excellence that this invention deserves to be noticed, but as an example of the strange delusions that not unfrequently lead ingenious men astray, and give rise to contrivances intended to produce impossible results. This invention consists, as the specification states, "in drawing smoke and other products of combustion from the fires of locomotive and other furnaces, by means of a fan-blower, in connection with either the fire-tubes of a locomotive furnace, or with the flue of other classes of furnaces. The smoke and gases after being thus drawn into the centre of the fan, are driven back through a return tube or flue communicating with the furnace below the fire-bars, thus causing the smoke and products of combustion to be passed through the fire and thereby consumed." The fan revolves on an axis fixed in the smoke-box, and the smoke having been drawn through the tubes of the boiler into the centre of the fan, it is there partially mixed with atmospheric air, and driven back again into the fire through a tube under the boiler. By this contrivance there is intended to be produced a continual circulation through the fire of the same smoke and gases evolved; a small chimney attached to the smoke-box, being intended merely "for the escape of any smoke that may not be driven back by the fan."

The necessary result of such a contrivance, if the action of it were as perfect as the inventor contemplates, would be to extinguish the fire by the continual return of the carbonic acid and nitrogen; and if the apparatus works at all, it must be in defiance, and not in consequence, of the principle of its construction. It is evident, indeed, that the action of the blower would tend to drive as much smoke through the chimney as through the return tube—and so far the object intended to be gained is frustrated; but if it did not do so, the fire would die out from the want of fresh atmospheric air. The inventor seems, indeed, to be unacquainted with the fact, that combustion depends on the supply of oxygen to the ignited fuel, or he would not have attempted to make a furnace burn with the products of combustion.

Hollow Axles.

A patent has been granted to Mr. James Newman, of Birmingham, and Mr. William Whittle, of Smethwick, for "improvements in the manufacture of axles." The principal improvement specified, consists in constructing the axle hollow, with a radial longitudinal arm passing through the interior from end to end; by which arrangement, it is stated, there is a great gain of lightness and rigidity. The method of making these tubular axles is very ingenious. The iron is, in the first instance, rolled or worked into the form shown below in fig. 1. It is then heated

Fig. 1. Fig. 2. Fig. 3. Fig. 4. Fig. 5.

and passed through a series of rollers, by which it is successively brought into the forms represented in figs. 2, 3, 4, and 5. The projecting flanges seen in fig. 1, are thus brought together in the form of a cross in the transverse section fig. 5, and being welded together in the centre, form a strong support through the whole length. The journals are afterwards rendered solid by the introduction of segmental pieces of iron at the ends of the axle, and by welding and rolling. The patentees also form solid axles on the same principle, by introducing through the whole length of the hollow axle, bars of iron shaped to fill up the interstices between the cross bars. The whole is then either welded together throughout, or is welded at the journals only. This form of axle promises theoretically greater strength than can be obtained by a solid axle wrought in one piece. The objection to it is of a practical kind, arising from the difficulty of working and of welding the interior pieces. If that can be overcome by the machinery which the patentees have contrived for the purpose, the axles thus made will be a great improvement.

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Railway Chairs.

Fig. 1.

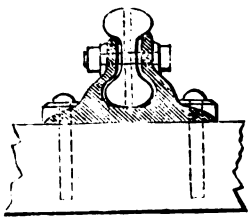
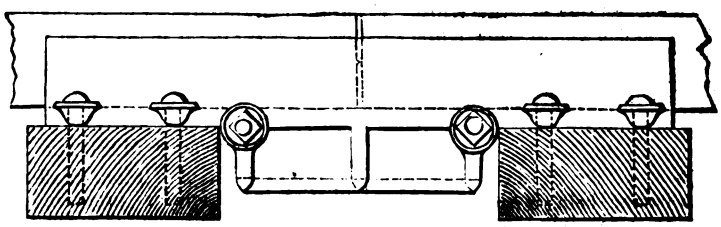


Fig. 2.



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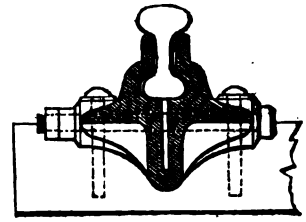

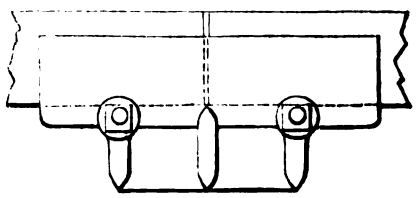

Fig. 4.

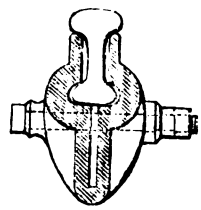

Fig. 5.

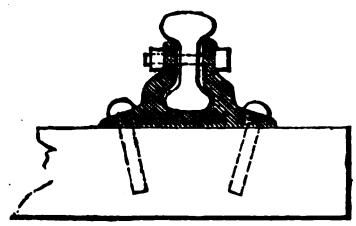

Fig. 6.

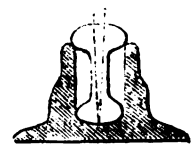

Fig. 7.

Mr. William Barningham, of Salford, has patented "improvements in connecting the rails of railways," which have for their object to connect the ends of the rails in a more secure manner, by giving them greater support than the ordinary methods afford. The accompanying engravings, from figs. 1 to 7, show the shapes of the proposed chairs in section, with side elevations of the rails supported in the manner proposed. Fig. 1 is a section of a joint chair, fixed on to a sleeper in the ordinary method, by spikes or trenails. The chair is put together in two halves, and the upper parts fit between the head and the lower portion of the rail, in such manner as to present a large bearing surface. The ends of the rails are firmly fixed to the chair by bolts, which pass through the ends of the rails and through slots in the upper parts of the chair. The chairs may be made of cast or of wrought iron. Figs. 6 and 7 show the forms in which they are made when wrought, fig. 7 being the shape into which the iron is first rolled, and fig. 6 the finished shape, with the ends pressed in to fit against the rail and increase the bearing. A modification of the jointed chair is represented in figs. 2 and 3, one being a side elevation and the other a section. The principal difference in this form of construction is, that the halves of the chairs are connected by bolts passing under the rails. A further modification is shown in side elevation and in section, in figs. 4 and 5. In this arrangement, the joint pieces which connect the ends of the rails, are also bolted together by bolts passing under the rails. In all these variations of form the same object is kept in view, of extending the bearing-surface at the joints, and thereby obtaining greater security and solidity. The invention seems good in principle, and if the divided chairs can be firmly fixed to the sleepers, it will be a considerable improvement.

Manufacture of Fuel.

Messrs. Watson and Oliver, the joint patentees of this invention for the manufacture of fuel, profess to produce a superior kind of coke by mixing with the coal to be converted into coke a large quantity of ground coke, or of ground coke and coal mixed together. In what manner the coke thus formed becomes superior to coke of the ordinary kind, is not stated in the specification; but admitting the quality of the new kind of fuel to be only equal to common coke, there would be a great economical advantage in the process, as it would turn to profitable account the small coal and small coke that are otherwise almost useless. The principal advantage of manufactured fuels is the conglomeration of the small coal, which cannot be burnt in furnaces, into lumps. When that is done by the addition of a tarry cement, the cost of manufacture raises the price of the fuel higher than that of good "knobly" coal; but the process of Messrs. Watson and Oliver produces a similiar effect without any additional material, consequently the fuel so made can be supplied cheaper than ordinary coke.

Furnaces.

A patent has been obtained in the joint names of Mr. I. B. Sharp, of Manchester, and Mr. Alexander Yorston, of Belfast, for "improvements in the arrangement and construction of furnaces or fire-places." The specification refers only to the furnaces of locomotive boilers, but the arrangement is also applicable to others. It consists principally in the application of a curved mid-feather to the furnace, as represented in the accompanying fig. 1, which shows a section of a furnace to which the invention is applied. In the drawing, A is a part of the boiler, B the outer casing, C the inner casing of the fire-box, and D the grate-bars, as in an ordinary furnace. The mid-feather, which constitutes the essential part of the invention, is shown at E. It is attached to the back plate, and two side plates of the inner fire-box. The fuel is supplied through two doors H and I, one above, the other below the division formed by the mid-feather. The compartment nearer the back is for burning coal, which is admitted through the door H, and in the other compartment coke is the fuel consumed. When both fires are lighted, the gaseous products from the coal pass under the mid-feather, and through apertures in it, so as to be exposed to the action of the incandescent coke in the other compartment, by which it is expected they will be ignited before entering the tubes of the boiler.

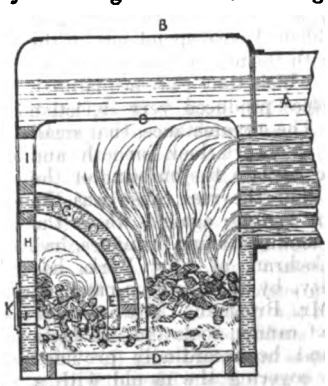

Fig. 1.

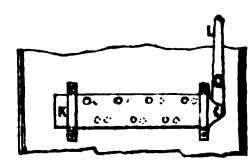

Fig. 2.

Fig. 2 represents the arrangement for admitting air into the furnace, for the combustion of the coal, the holes being (by means of a lever L) closed by a slide-plate K, for regulating the quantity admitted.

The object attempted to be accomplished by this arrangement is to make the furnace burn its own smoke, and thus to allow of the use of coal in locomotive engines. There does not appear, however, to be any contrivance for the supply of air—the thing most needed for the special combustion of the smoke, which is generally heated in ordinary furnaces sufficiently for combustion if the necessary quantity of air could be supplied. In Mr. William's arrangement, for example, jets of air are intro-

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duced in the bridge of the furnace, which cause the combustion of the heated inflammable gases and carbon without requiring additional heat, and a similar arrangement obtains in other furnaces intended for the combustion of smoke. In this joint patent of Messrs. Sharp and Yorston, however, there is the provision of additional heat, which is almost unnecessary, whilst there appears to be no provision for the due supply of air, on which combustion depends.

Air Engine.

Mr. A. V. Newton has taken out a patent, being a communication from some one not named, for "an improved construction of air engine." The various attempts hitherto made to obtain an available motive power from the expansive force of heated air have proved unsuccessful, nor do we perceive in the "improved construction" now patented the means of overcoming the difficulties that have attended such attempts. The invention is stated to consist in "charging the regenerator and heater with fresh compressed air at each stroke of the engine, without the employment of a supply pump, by the peculiar combined movements of two pistons within the working cylinder; the introduction of fresh air, and its transfer to the regenerator or heater in a compressed state, being effected under a state of equilibrium of pressure, so that the supply piston becomes entirely relieved from resistance during the process of charging the regenerator or heater, whilst at the same time one of these pistons performs the office of working piston, exerting full force on the engine without suffering retardation by any unbalanced pressure against the supply piston." The objects which the inventor attempts to accomplish are, to compress the air before it is heated, and to heat it partially by the waste heat of the air escaping from the cylinders after it has done its work, by allowing it to pass through a series of small tubes, introduced into a chamber through which the waste air passes. The notion that the air is compressed without any exertion of power by "a state of equilibrium of pressure," is manifestly founded in error, and there seems to be consequently no advantage gained by the previous compression of the air. We shall not now enter into the question, whether it is possible by any mechanical contrivance to make the pressure of heated air economically available as a substitute for steam. It is enough for the present to say, that the problem has not been satisfactorily solved by the "improved construction" patented in the name of Mr. Newton.

Casting Mortars and Cannon.

The question now in dispute between the government and Messrs. Grissell, gives increased interest to an invention which professes to overcome the difficulty which attends the casting of ordnance. It appears from the published correspondence on the subject, that the Messrs. Grissell, with the most honest intentions and adopting the best means with which they were acquainted, and using the best iron, nevertheless produced very defective mortars, which burst in proving. The circumstance, that small holes had been plugged to make the work look smooth and finished, does not seem sufficient to explain the bursting of the mortars, and it is most probable that the real cause was the unequal contraction of the metal in cooling; against which the engineers, not being accustomed to manufacturing ordnance, had not sufficiently provided. Mr. Cochran, of New York, has endeavoured to obviate this difficulty, by an invention patented in this country in the name of Mr. Brooman. The inventor assumes that the external surface of cannon cools and contracts sooner than the inner surface, and he accordingly provides against this assumed inequality, by covering the mould with a non-conductor of heat, and by refrigerating the core. To do this, he employs an outer casing of gypsum, and a hollow iron core, the outside of the latter being coated with loam. He then introduces a tube to near the bottom of the hollow core, through which tube he injects a stream of cold water or air. By this arrangement the interior surface is cooled whilst radiation from the exterior of the casting is diminished.

It seems very questionable, whether this arrangement would be attended with the good effects the inventor contemplates. The proposed remedy, we suspect, would be found to produce worse consequences than the ordinary process of cooling. By this plan the interior would be cooled much more quickly than the exterior, and the evil of unequal contraction would consequently be increased. The most effectual way of preventing the brittleness arising from irregular contraction, seems to be the adoption of some process similar to that of annealing. If, therefore, Mr. Cochran had contrived a means for retaining the heat altogether, instead of retaining it in one part, and abstracting from another, he would have been more likely to have attained successful results.

Fire-proof Material for Furnaces.

Mr. David Hill, of Tipton, Staffordshire, forge-manager, has patented an invention for "preparing a material capable of resisting fire, and especially suitable for the interior of puddling and other furnaces." In this preparation, the inventor employs materials that have been subjected to the greatest heat that furnaces excite. The combination consists of limestone and ironstone, or the cinder from furnaces, which are melted together and cast into moulds. The proportions of the materials may be varied, but the following are preferred:—one-sixth part of limestone, and two-third parts of ironstone or cinder. These are mixed together and fused. Mr. Hill's experience as a forge-manager, has no doubt taught him that the vitrified slag of the furnace is well adapted to resist the heat by which it has been melted, and in this respect it accords with the observations of Mr. Truran (whose book on iron manufacture is elsewhere noticed), that the vitreous covering of the bricks protect them from the further action of fire. The specification of the invention is one of the shortest on record: the descriptive part and the claims only occupy twelve lines.

Steam-Engines and Pumps.

An invention having for its objects "certain improvements in steam-engines, part of which is applicable to pumps," was provisionally protected by Messrs John Rhodes and John Johnson, in September last, but the notice to proceed with the application for letters patent not having been given in time, the protection has expired. The principal part of the invention consists in the construction of pistons with metallic expanding rings, to be held in contact with the interior surface of the cylinder, by the admission of compressed steam to the interior circumference of the rings. When these pistons are applied to pumps, the expansion of the packing rings is produced by the action of water. The manner of constructing the rings, and of admitting the steam or water, is not explained. The invention also relates to "expansive governors, consisting of cams actuated by centrifugal force, in such a manner as to open the induction valve into the steam cylinder in variable periods of time," according to the work to be done. Another part of the invention relates to slide-valves "for excluding the steam from the back of the same." These slide-valves are made with an annular space at the back for the reception of hemp or other packing, with a metallic ring to work steam-tight against the interior of the cover of the slide-valve casing, the packing and ring being "adjusted by screws, actuated by wheels working into each other, and by other suitable mechanism." The description of these various contrivances is too general to enable us to pronounce decidedly on their merits, but the combination of wheels, screws, and "other suitable mechanism" for the working of the slide-valves, sounds not very promising for the practical working of such an arrangement.

SUBMARINE TUNNELS.

A scheme has been proposed for connecting Liverpool with Birkenhead by a triple-way-tunnel, to be constructed under the Mersey, and which if carried out will prove of great benefit to those towns. It is proposed to use one arch for a double line of railway, another for wagons, carts, vans, &c., and the third for light vehicles, equestrians and pedestrians; the whole to be lighted with gas and well ventilated. This scheme is a modification of the proposed tunnel from Dover to Calais, and it is intended shortly to submit a similar plan for connecting New York with Brooklyn. The designs and arrangements are by Mr. W. Austin, C.E., for many years in the establishment of Messrs Peto, Betts, and Brassey, as manager and director of works. Mr. Austin proposes to apply his patent on the double-dovetail principle to the formation of the tunnel.

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ON A NEW DUPLICATE RETORT STEAM BOILER.

By THOMAS DUNN, Manchester.

[*Paper read at the Institution of Mechanical Engineers.*]

THE difficulties and expenses attending the transit of large steam-boilers made on the ordinary construction, in consequence of their unwieldy size, led the writer of the present paper to consider the feasibility of forming a boiler in parts, in such a manner that it should possess the advantages of the ordinary large boilers, without their disadvantages.

The large boilers in common use weigh in some cases 18 tons, and their bulk is sometimes a greater objection to them than their weight, causing great loss of time and expense. As a practical illustration, some cases may be referred to, that have occurred recently in the writer's experience, and have caused great inconvenience and expense.

A 50-horse power boiler that had to be sent to the neighbourhood of London, measuring 22 feet long and 6½ feet diameter, could not be conveyed the whole distance by railway, from want of sufficient clearance under the bridges, and had to be drawn part of the way on the common road, requiring 24 horses, and more at the hilly parts, causing serious expense and delay.

In another case of a pair of boilers, 24 feet long and 6½ feet diameter, with a dome 3 feet high rivetted upon each, the same cause prevented them from being conveyed by railway, and a similar difficulty occurred on the common road from the arch of a bridge being too low.

In shipping to foreign countries, the great bulk and weight of boilers becomes a very serious objection, and in the case of a 30-horse power boiler, sent by the writer to Canada, 20 feet long and 5¾ feet diameter, and weighing about 9 tons, the expense of transit was increased to at least three times the value of the boiler, by the extra expenses attending the shipping and unloading of so large and heavy a mass, and the difficulties of conveyance over bad roads after landing.

From the above examples, and many others that might be cited, it will be apparent that a boiler capable of being readily transported would cause great saving in time and expense of transit. Such a boiler must also satisfy the following requirements:—it must be able to stand a working pressure of not less than 200 lb. per square inch; and it must be of simple construction, and must admit of being easily repaired.

These conditions, the writer believes, are fulfilled by the new boiler described in the present paper, which consists of a series of small cylindrical boilers or retorts placed side by side, and connected together by pipes at the extremities, the number of retorts being such that their total capacity shall be equal to that of a single large boiler of ordinary construction.

The new boiler is shown in the accompanying engravings:—Fig. 1 is a plan; fig. 2, a longitudinal section, and figs. 3 and 4 transverse sections. A A are the cylinders or retorts, made of the best wrought-iron plates, ¼-inch thick, 9 feet long, and 17 inches diameter; the ends are cast-iron hemispherical caps, ¾-inch thick, rivetted upon the cylindrical portion, to which are fixed the cast-iron connections from the steam-chest B, the feed-pipe C, and mud-pipe or blow-off pipe D. The retorts are built into the side walls of the furnace at each end, and supported on a saddle of firebrick in the middle; they are placed 1¼ inch apart, the space between them being closed by a wedge-shaped piece of firebrick leaving the whole of the lower semicircle exposed to the flame, and half of the upper. The plan represents nine of the retorts arranged side by side and across a double furnace. The flame traverses the bottom of all the retorts, and then passes to the top through the double arch E, returning over the retorts to the front, and thence to the chimney at F. The retorts have thus three-fourths of their surface exposed directly to the flame, and, consequently, absorb a great quantity of heat. The cast-iron ends are outside the walls of the furnace, so that they suffer no injury from exposure to the flames; whilst their extra thickness keeps in the heat, and renders them stronger than the other parts of the boiler.

The steam-chest B, the feed-pipe C, and the mud-pipe D, send off branches to each retort, whereby the steam is carried off equally from all, and an equal distribution of the feed water is produced. The feed water is introduced at the opposite end to that at which the steam is taken off, but the mud-pipe is at the same end as the steam-pipe and the opposite end to the feed-pipe, and thus the boilers can be thoroughly cleared of scale or deposit, as often in the day as may be desired, by simply opening one or both of the blow-off cocks, situated at the ends of the mud-pipe. The opposite end of the retort, at which the feed water enters, is cast with two connections, one of which receives the feed-pipe, and the other is closed by a cover plate; by this means, when the boiler is reversed to equalise the wear, the bottom being turned upwards, the feed-pipe connection then becomes the closed one, and the one previously closed now receives the feed-pipe; at the same time, the connections of the steam and mud-pipes at the other end of the boiler are also reversed, merely requiring the flange joints to be broken. Each end is provided with a manhole, and thus the boiler can easily be laid clear open from end to end.

In this boiler there is no internal flue, and no part is exposed to a pressure from without, tending to make it collapse, but all the pressure is from within. The nature of the pressure thus renders the boiler safe, in contrast with those having an internal flue, the danger of which has been experienced in several recent accidents; in one instance, the pressure was 45 lb. per square inch when the flue collapsed, and in the case of a locomotive boiler, having a return flue 30 inches diameter, made of ½-inch Lowmoor plate, the flue collapsed and blew up the engine when it had not been at work more than a week.

The retort-boiler has no small tube connected with it, and thus saves the trouble and expense which they occasion, particularly with dirty water or inexperienced attendants; at the same time there is less tendency to accumulation of deposit, the interior of the retorts being uninterrupted; and in case any dirt should collect, the mud-pipe D gives every facility for cleaning out, and the retorts may be examined at any time by means of the manholes at each end.

The peculiar construction of the boiler prevents the adhesion of incrustation or scale of more than $\frac{1}{16}$-inch thickness to the internal surface, as the contraction from the boiler cooling at night loosens the scale, and the formation of the fresh scale forces it off. Upon removing the manhole doors to clean the boiler, the deposit was found in two of the retorts only, the remainder being almost free from deposit of any kind, after 13 weeks' constant working.

The small diameter of the retorts increases their strength, and accordingly a boiler of this description is stronger than a single large boiler of equal power. One of the retorts has been proved by hydraulic pressure up to 300 lb. per square inch without bursting, being at the least three times the ordinary working pressure.

The several parts are all duplicates of one another, so that they can be easily replaced when injured or worn out; or the power of the boiler can be increased, when desired, by adding more retorts; and the plain cylindrical shape of the retorts allows of their being reversed so as to equalise the wear.

The new boiler combines with it abundance of furnace room, allowing the more bulky kinds of fuel to be used, such as brush-wood, peat, sawdust, or the cheapest sort of coals, and affording space for the addition of any kind of smoke-burning apparatus that may be desired.

A boiler of the above construction has been at work upwards of ten months at the writer's works, in Manchester, and given complete satisfaction. It supplies steam at a pressure of 50 lb. per square inch to two engines, one with a cylinder of 8½ inches by 2 feet stroke, making 60 revolutions per minute, and the other with a cylinder of 7½ inches by 18 inches stroke, making 80 revolutions per minute. The indicated horse-power of the two engines together is 17-horse power, the average pressure of steam in the large engine being 28½ lb. per square inch, and in the small engine 27 lb. per square inch. The boiler also works a steam rivetting machine, 30 inches diameter, and equal to 7-horse power. This, together with the two engines, gives a total of 24-horse power. The consumption of fuel is 135 lb. per hour of ordinary furnace coals, or about 5¾ lb. per indicated horse-power per hour; but the boiler is working at a disadvantage owing to the length of the steam-pipes connecting it with the engines, one being 180 feet long and the other 84 feet, and passing through an open yard. Taking into consideration the loss caused by radiation from this extent of surface, it appears that the new boiler is economical and cheap, as it can be made at the same price as an ordinary large boiler of the same power. Also in consequence of the small weight of the separate parts of which it is composed, the heaviest of which does not exceed from 7 cwt. to 8 cwt., it can be shipped or loaded for overland transit at the price of ordi-

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Dunn's Duplicate Retort Steam Boiler.

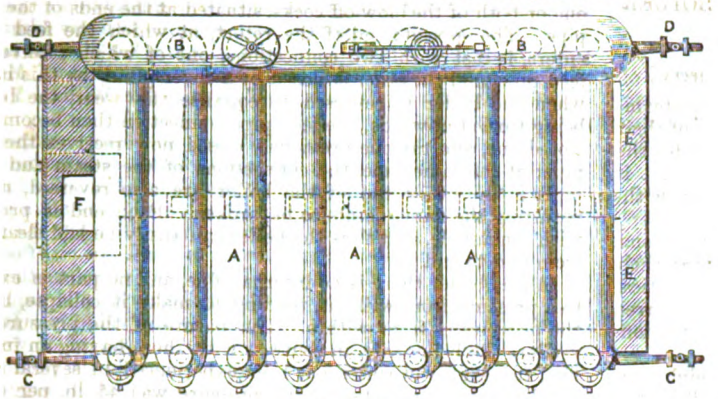

FIG 1.—PLAN.

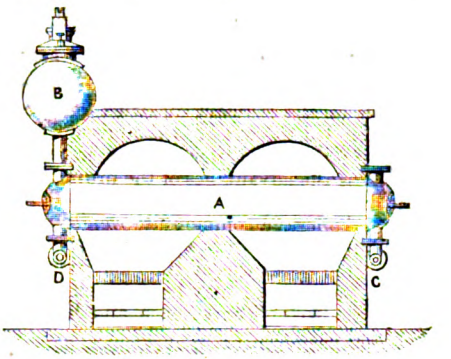

FIG. 3.—TRANSVERSE SECTION THROUGH FIRE.

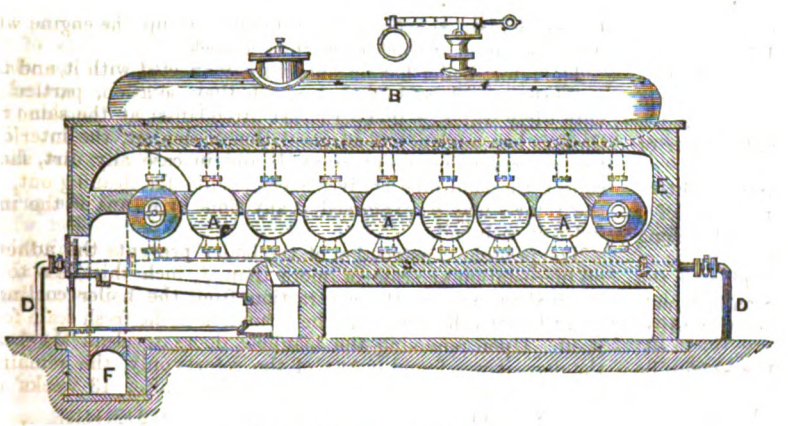

FIG. 2.—LONGITUDINAL SECTION.

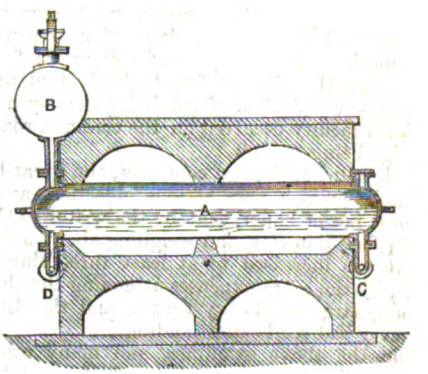

FIG. 4.—TRANSVERSE SECTION THROUGH FLUE.

nary machinery, with an important saving over the large boilers at present manufactured.

Discussion.—Mr. RAMSBOTTOM (the Chairman) observed that the boiler described appeared to be designed more particularly with a view to portability and lightness, and those qualities would certainly be of considerable advantage in many cases. From the mode of setting the boilers with a portion of their upper surfaces exposed to the flue, it appeared that the steam would be partially surcharged with heat, and some caution would be requisite to prevent this being carried to any objectionable extent.

Mr. DUNN replied that it was only the return flue, to which the upper surface of the boilers was exposed; the flame first passed under the whole of the retort boilers, acting on the lower half of their surfaces, and then returned over the top of all of them, acting there on half of the upper surface, and leaving one-quarter of the entire surface of each protected by the wedge-shaped fire-bricks fitted in between the retorts; he did not think there was any risk of heating the steam too much.

Mr. SIEMENS thought the steam would certainly be super-heated to some extent by the exposure of the upper portion of the boiler, but this would prove an advantage, as steam in first rising from water was always in a state of transition, containing a portion of water mixed with it, being more or less imperfect as a gas. When this steam was heated, a very rapid rate of expansion took place during the first few degrees, from the whole being transformed into a perfect gas; but the expansion afterwards progressed at a very slow rate, approximating to that of the expansion of air by heat. Super-heated steam gave an important advantage in working expansively, as the steam, on entering the cylinder, at the beginning of the stroke at a high temperature became partially cooled at once, by the cylinder being only at a mean temperature considerably below the highest; and in this case, with ordinary saturated steam, the consequence of its being cooled was the condensation of a portion of the steam at every stroke, depositing a dew on the sides of the cylinder; but if the steam were super-heated sufficiently, it would not be cooled down to the condensing point, and no water would be formed in the cylinder. The difficulty in practically applying super-heated steam, was the risk of over-heating it, in which case it dried up the lubricating material of the cylinder, and caused the piston to grind. The boiler that had been described, appeared a good plan for accomplishing the object, under safe control.

Mr. T. FORSYTH had seen the boiler at work, and was much pleased with it; it was a very strong construction, and the arrangement was particularly convenient for transit; he had had experience on railways of the serious difficulties and delays attending the carriage of large boilers, which Mr. Dunn's arrangement would obviate. He agreed fully in the value of super-heated steam, and thought the circumstances of the present boiler having worked for eight months at the time he saw it, without any objection being experienced from the steam being over-heated, was a good test of the principle having been applied within safe limits.

Mr. RAMSBOTTOM enquired what difference of water-level was found throughout the boiler; and whether any difficulty had been experienced from priming.

Mr. DUNN replied that the water-level was about 1 inch above the centre of each boiler, and very little difference in level was perceived between the two end boilers and the middle one, where water-guages were fixed. There had not been any difficulty from priming, and he thought the boiler was more free than usual from this objection.

Mr. RAMSBOTTOM enquired what difference was found in the deposit as compared with the old boiler that had originally supplied the place of the present boiler, and what was the quality of the water used.

Mr. DUNN replied that there was a considerable proportion of earthy matter in the water, and a crust was formed in the old boiler of $\frac{3}{8}$ to $\frac{1}{2}$-inch thickness in the course of four months; but in the new boiler the incrustation never extended beyond the formation of thin scales, less than $\frac{1}{8}$-inch thickness (specimens of which were exhibited), which became regularly shelled off by the alternate expansion and contraction, and were mostly blown out at th mud-pipe.

Mr BEYER had seen the boiler, and the feature that struck him

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most was that there was nothing but internal pressure throughout; he thought it was a step in the right direction, especially for boilers intended for high pressures, where external pressure upon cylindrical flues became particularly unadvisable. As to priming, it must be observed that there was a greater proportion of water surface than usual, which rendered the liability to priming less, by diminishing the violence of ebullition. There was also a separate steam-chamber, which would help in separating the water from the steam.

Mr. RAMSBOTTOM enquired the comparative results in consumption of fuel with the old boiler and the present one, which had been stated to burn 5½ lb. of coal per horse-power per hour.

Mr. DUNN said he was not able to give the comparative consumption of the old boiler with sufficient accuracy to be of service; it was a cylindrical boiler, with a single flue, but was old and out of order, and the consumption would be above the average.

Mr. JACKSON observed, that it was important to have an economical boiler, and some constructions in use were much more expensive in fuel than others.

Mr. LONGRIDGE thought a consumption of 5½ lb. per indicated horse power was rather high, but the engine might perhaps be in some fault; some engines in the neighbourhood were working with only 3 lb. of coal per indicated horse-power per hour. He enquired whether the water evaporated per lb. of fuel could be stated, as that was the only correct test of economy in the use of the fuel. In the boiler that had been shown, he thought there would be some risk of over-heating the steam too much, as the brickwork at top might perhaps get red hot; there were certainly advantages in super-heating the steam, if this were not carried too far, but it was very important to avoid any risk of such an occurrence.

Mr. DUNN said he had not had an opportunity at present of correctly measuring the water evaporated; he did not suppose the boiler was quite so economical in fuel as some of the best forms, but thought it would show a good comparison with those in ordinary use. His particular object, however, had been to obtain portability and convenience for repairs and renewal.

Mr. BEYER remarked that the boiler that was at work could not be taken as a test of the evaporative economy of the plan, in consequence of the great extent of steam-pipe and steam-chamber exposed to loss of temperature.

THE GOVERNMENT BARRACKS COMPETITION.

As must inevitably be the case with all competition designs, a considerable amount of disappointment occurs, and acrimonious feeling is elicited, from the unsuccessful candidates. We took the opportunity of examining the 114 sets of designs which have been on view at Burlington House, viz. 25 for the cavalry and 89 for the infantry barracks, and confess that in our opinion the selections appear to have been very judiciously made. In reference to the prize No. 1, awarded to Mr. Morgan, of Chancery-lane, London, no *unprejudiced* mind can deny that the award is most truthful, and that the plans and elevations sent in by that gentleman, in point of general utility of purpose, simplicity of design, and architectural effect, carry the palm in a most eminent degree.

There are good points unquestionably about the design, prize No. 2, by Messrs. Lockwood and Mawson, of Bradford, which reflect great credit on the talent existing in the provinces; but no one, we think, will fail to admit that the principal façade in particular is too much cut up, and at the same time there is an error in composition in making the extreme masses at the ends of the elevation more prominent than the centre one. Prize No. 3, by Mr. Jones, Seaforth, near Liverpool, has too much of the almshouse character about its composition, a style at variance with the requirements of barracks. No. 11, set of designs, with the motto, *Nec aspera terrant*—deserves notice in reference to the drawing of the principal elevations in perspective, which are executed with great care, and, although only in outline, are extremely effective.

In reference to the designs sent in for the cavalry barracks, the first prize No. 1, has been awarded to Messrs. T. H. and M. D. Wyatt, of London. The ground plan is simple, and the elevations generally range no higher than two stories. The riding-school is situated in the centre, and is spacious and well ventilated.

The second prize has been awarded to Mr. George Morgan, the same gentleman who is the successful candidate for the first prize in the infantry barracks, and contains so many admirable points in it, that it must have been a somewhat difficult matter with the committee to decide between it and that of Messrs. Wyatt. The third prize has been given to Mr. William Young, of Chancery-lane.

It is trusted, after this exhibition, that the future competitors will take a careful lesson, to the effect, that it requires no great amount of elaboration, and a gaudy splashing about of colour, to make a really good design; and that, after all, it is not a pretty perspective and picturesque drawing that will carry the palm, —at least with judicious judges in such matters. In proof of this, we may instance the slightness and simplicity of colour that distinguishes the first prize for the infantry barracks, and numerous others, did our space allow us to do so individually. It is a source of much regret, to think on the amount of unwearied study and application that has been involved in the production of these 114 sets of designs and specifications, and the suggestion forces itself upon us, if it were an act of justice only, that there should be a *certain pecuniary amount awarded to all the unsuccessful competitors*, as well as their more fortunate brethren; and when we reflect seriously on the thousands of pounds of the public money that are about to be spent in illuminations which are utterly useless, surely a few hundreds might be spared to reward honourable artists who have devoted their valuable time and talent in the service of government and the country. The amount for the prizes in both instances, were—for the first, 150*l.*; the second, 100*l.*; and the third, 50*l.*

In proof that the committee appointed to award the prizes, gave that cool and deliberate consideration to the subject which its importance required, we may state that these examinations and deliberations extended over a period of eight days, and we feel an entire confidence that the awards have been conscentiously and judiciously given.

JUNIO.

ST. ALBAN'S ABBEY, HERTFORDSHIRE.

AN interesting movement is now in operation, having for its object the restoration of St. Alban's Abbey,—to a sufficient extent, at least, to make it available as a cathedral, in the event, which is by no means improbable, of its being shortly raised to that distinction. At present the people of Hertfordshire have their cathedral on the other side of the Thames, and their bishop living near the German ocean,—a state of things by no means to be desired. But independently of this, as a specimen of architecture now humbled and too much neglected, the abbey has claims to preservation which few other edifices can offer, and the authorities have wisely consulted Mr. G. G. Scott as their architect. His successful efforts at Ely and other cathedrals are well known; and he has submitted an excellent report on the question before us, to which we shall presently refer in explanation of the alterations he considers will be needed to place the structure in a worthy and available condition for the hoped-for purpose.

Of the interest which attaches to St. Alban's in an historical and antiquarian point of view, it is hardly necessary to speak. As the successor of the great British and Roman Verulam, and the scene of many of the greatest occurrences in the history of our island, its claims are self-evident. The question, too, as to its church, would not be whether it is the most interesting in its history and associations of any in the proposed new diocese, but rather whether it is not more so than any other church in the kingdom. Founded in the days of Constantine the Great, in honour of England's first martyr, and within ten years of his martyrdom, it is probably the earliest in its authenticated foundation of any church now existing in Britain.

Bede distinctly says, that the Romano-British church of St. Alban remained in his day; and, a century later, the body of the martyr, which had been removed during the Saxon invasion, was restored to the ancient church by Offa, King of Mercia, and an abbey founded in connection with it. The last two Saxon abbots collected vast stores of materials from Old Verulam for the rebuilding of their church, a work carried into execution by the first two Norman abbots on a scale so gigantic as even now to astonish the beholder; and, for the next four centuries and a-half, St. Alban's ranked among the greatest of the ecclesiastical foundations in England; her abbot, during the greater part of

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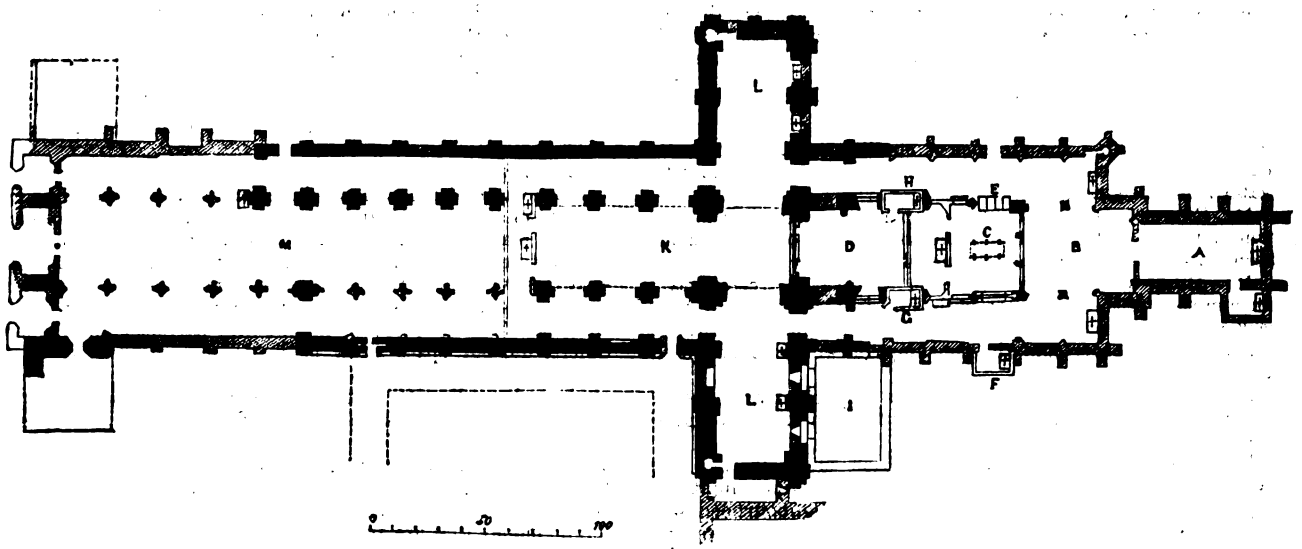

References to Plan, St Alban's Abbey Church.

A. Lady Chapel.	D. Sanctuary.	G. Abbot Wheathampstead's Chantry.	K. Choir.
B. Eastern Aisle.	E. Watching Loft.	H. Abbot Ramridge's Chantry.	LL. Transepts.
C. Feretory.	F. Duke of Gloucester's Chantry.	I. Sacristy.	M. Nave.

that time, not only being a peer of the realm, but taking precedence of all the other mitred abbots in England.

Particular regard seems to have been paid to laying out the plan of the church, and fixing the subdivisions for the positions of the piers; and measurement proves that, with a slight exception, this part of the work was performed with such ability, that only trifling deviations from accuracy and uniformity occur. The Norman portion of the existing edifice was commenced about 1077, on the previous site, and dedicated in 1115. When seen in its full proportions, with its three towers, the central one augmented in height and beauty of appearance by its lofty octagonal lantern and tapering pinnacles, it must have been assuredly an imposing edifice as well as a striking feature in the landscape.

The materials of which the earlier work is constructed are curious. A large proportion consists of Roman brick, and the way in which it was originally employed is here clearly evident, especially in portions which have not been plastered over;—of such the belfry stage in the large tower is an interesting specimen. The brick is mostly of one size, namely, 16 × 12 × 1½ inches; and no less regard was paid to lapping the courses, or preserving the bond, than could have been in the construction of masonry. Some of the bricks have been vitrified and warped by excessive heat, while but few seem to have yielded to the action of the weather upon the exterior of the building. They are mostly of a deep red colour, but many in the interior of the belfry are of white earth.

The length of the abbey building in the clear, from east to west, was 440 feet, terminating in an apse; the nave, or western arm of the cross, measured internally 270 feet, and the transept from north to south was 176 feet. A reference to the annexed plan will give an accurate idea of the general arrangement, as well as of the enormous space it includes; the different periods of erection are distinguished by different tints. The church, thus extended, exceeds in length any other church or cathedral in Great Britain; and though in other dimensions it falls short of York, and some others of our greatest churches, it as a whole, would rank in point of extent among our principal cathedrals.

Not to dwell upon the fact just mentioned, that its walls are composed of materials from ancient Roman structures (probably also including those of the church erected under Constantine), and that several architectural fragments remain of undoubted Saxon date,—we have in the building—first, an example, on a vast scale, of the earliest Norman architecture, forming the great bulk of the building, including, also, the great central tower; we have, secondly, an extremely beautiful specimen of the later and more enriched Norman, in the passage or "slype," at the southern transept; thirdly, we have the incipient works in the west front, including, probably, the three beautiful western porches, works of the earliest pointed architecture, executed in the days of King John; and in conjunction with these, and on either side the nave, we have a majestic specimen of the same style in its future development, executed early in the reign of Henry I.; fourthly, we have in the choir a highly-finished work of the end of the same reign, evincing the rapid growth and refinement of the art at that period; and, adjoining this, in the half-ruined eastern aisle, is a truly exquisite specimen of the same style slightly more advanced, and probably executed in the time of King Edward I. In the nave again, in the eastern half of the south side, we have a most noble and magnificent specimen, belonging probably to the close of the same reign; in the marvellous Lady-chapel is seen the Middle-pointed or Decorated style in its fullest characteristics; while, lastly, in the monumental chapels of Abbots Wheathampstead and Ramridge, and of Humphrey Duke of Gloucester, and in the magnificent altar-screen —rivalling and closely resembling that at Winchester—we have splendid illustrations of the final era of Gothic architecture, and unfortunately, in many insertions into the older work, we see numerous instances of that decline which preceded its ultimate extinction.

So vast a fabric could not be kept up with the slender endowments which, in these later times, remained to it, and (as might be expected) it has, during the last three centuries, undergone a gradual falling off from its original beauty. On several occasions, however, great endeavours have been made, and extensive works of reparation effected,—some about twenty years back, under the direction of the late Mr. Cottingham;—and a praiseworthy spirit in the present rector has been the means of continuing exertions and securing some judicious and valuable restorations.

Mr. Scott's report goes on to point out the requirements of cathedrals, and the practical fitness of the building under consideration to meet such requirements:—

"The plan of the church being substantially like that of most of our cathedrals, there can be no reason why it should not be as well suited to its purpose as they, * * * and, fortunately, the point in which it differs from some of our cathedrals—viz., the shortness of the eastern arm—is all in our favour.

"The choirs of our cathedrals, originally intended for the members of the ecclesiastical establishments attached to them, have become, in later times, mere chapels cut out of the vast edifice, and occupied almost promiscuously by clergy and congregation, with little regard either to ecclesiastical order or practical convenience. Those who have given their thoughts to the subject, have long felt that the great desideratum in a cathedral, for our ritual, is to provide a moderate choir, proportioned to its actual uses, and a spacious nave, capable of accommodating, conveniently, and within reach of the voice, a large assembly of worshippers. This seems attainable at St. Alban's, without destroying any of the ancient landmarks which the ecclesiastical antiquary would naturally wish to retain. The ancient choir and sanctuary extended from the great altar screen, through the central tower and three bays or arches into the western portion of the cross, including a length of 180 feet;—an extent far greater than that of any unaltered choir in the kingdom.

"The form of the space between the eastern and western screens is

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(as has been several times pointed out) eminently calculated for the re-arrangements suited to our present requirements. It embraces a cross, of which the eastern arm is about 60 feet in length—a size well fitted to form a good practical choir, suited to our existing uses—while the space below the tower, and onwards to the western screen, with the whole, or portions, of the two transepts, will form a good nave, capable of containing a very considerable congregation; probably exceeding that which is provided for in any other of our cathedrals in which the choir screens are retained. The pulpit being placed (as now) against one of the eastern piers of the tower, would command a complete view of all the arms of the cross, and the whole would form, I do not hesitate to say, the most perfect and consistent cathedral arrangement in England.

"The circumstance that there still remains a vast nave to which no specific use is alloted, does not affect the fact that the rest is well suited to its purpose; possibly uses may hereafter suggest themselves which do not now occur to us."

In treating of the works necessary to be done in order to prepare the church for its altered uses, Mr. Scott says:—

"These works may be divided into three classes:—1st, those which are essential, as resulting from, and necessarily connected with, the change in the uses of the building; 2ndly, those which, though not essential, seem so naturally to follow upon the contemplated increase of dignity, that consistency would appear to demand them; and, thirdly, such as (though desirable) are neither essential nor demanded on the ground of consistency.

"The great and most essential work is, manifestly, so to refit and re-arrange that portion of the building especially set apart for public worship, as to render it fit for the reception of the bishop and cathedral staff, both clerical and choral, with the dignity becoming a great ecclesiastical establishment; providing all other internal fittings and arrangements on a suitable scale, and putting the interior of this portion of the church into a state of perfect, substantial, and decorative repair,—so far as this may not be thought to infringe upon objects of antiquarian interest.

"To go more into detail: the refittings would consist of a new altar table of suitable design, with proper coverings and appurtenances; an episcopal throne of becoming dignity; canopied stalls for the dean, subdean and chapter, with desks and subsellæ in front, and all requisite provision for the vicars, choral and choristers; a low choir-screen of open metal-work across the eastern arch of the tower, and all the minor requirements of choral arrangement; a new organ, so placed and constructed as to be an ornament rather than an obstruction, and conveniently arranged both for the choir and the congregation; and a handsome new pulpit (perhaps of Purbeck marble); and oak seats throughout the part to be occupied by the congregation, with requisite screens to sever this from the parts not so used. All these should be executed in a style proportioned to the magnificence of the building, their details perhaps agreeing in character with the style of the choir itself. The pavements of all these portions should be proportioned in richness to their position, but in no case interfere with any ancient sepulchral stones, which must be carefully preserved *in situ*.

"The repairs necessarily and immediately connected with the above, can hardly be described in a brief outline like the present. It is quite clear that they must be considerable; but, on the other hand, it is equally so that they must be of the most delicate character, every touch being thoroughly considered, as, otherwise, the antiquarian value and interest of the parts affected may be infringed upon. It is clear, in the first instance, that all parts must be made substantial and secure, that the stonework must be cleared from any coatings of whitewash which may remain upon it, but so carefully as to leave the ancient tooling and any remnants of colouring unobliterated; parts wantonly cut away (such as the shafts attached to the pillars) must be restored exactly according to the original, and the whole repaired in the most careful and conservative spirit, rather leaving mutilations unrestored than restoring them in a conjectural manner. I prefer, at the present stage, to provide liberally in my estimate for these works of restoration and decoration, rather than specifically to define them, as each must be the result of careful and deliberate thought, and no general principle can be precisely laid down for their execution.

"One thing more is required to complete my list of essential works; I mean the erection of spacious vestries for the chapter and choir. These should be on the site of the ancient vestries, now destroyed, adjoining the south transept and the south aisle of the choir.

"The above is all which is absolutely necessary to render the building fit for cathedral uses. The work is open to much variation, as to the degree of ornamental character given to it; but, executed on a scale becoming the dignity of the church, it would, I am of opinion, come to from 12,000*l*. to 13,000*l*.

"The next class of work which I would recommend, as following on the ground of consistency, is the general restoration of the interior of the choir, which is sadly decayed and mutilated; and of which the details are so extremely fine as to render their preservation of the utmost importance. Also the complete repairs of the aisle roofs of the nave, which are in a bad state—such repairs as may be requisite to other roofs (most of these I may mention, were carefully repaired by Mr. Cottingham); the examination and repairs of such parts of the foundations as show signs of weakness (this is chiefly confined to the nave aisles); and the careful drainage of the building, with such other works as are necessary to the substantiality of the whole structure. These works I estimate at about 5000*l*. or 5500*l*.

"The church, thus re-arranged and repaired, would have all the practical requisites of a cathedral, and would be a thoroughly substantial building—quite as much so as most of our cathedrals, and far more so than many of them; for, be it remembered, the structure is in the main remarkably strong and substantial, and its principal roofs in good repair.

"The third class of works which I have enumerated I may leave indefinite. It consists of those restorations—desirable in themselves if conservatively executed,—but in no degree resulting from, or necessary to, the change from a parish church to a cathedral. Such works may fairly be left to the zeal of the future chapter, and might be executed under their direction, from time to time, as funds may admit. Such would be the external restoration of the beautiful clerestories of the nave, now sadly decayed; possibly, the restoration of the magnificent western portals—(this, however, would be a work of great difficulty); the general restoration of the nave;—and, should ever the exquisite eastern chapels happily be restored to the church, their thorough reparation would come under the same category. Indeed, if they could now be obtained, a slight increase of funds would include them in the second class of repairs, to which they naturally belong; and this would be the most beautiful and interesting addition to the work which could well be imagined."

An influential meeting, to promote the general object, was held at the town hall, St. Alban's, on the 3rd ult., when the architect's report was read, and resolutions in support of it adopted. As a substantial evidence of the interest created, it may be mentioned that the contributions announced in the room after the meeting amounted to 4205*l*.

BUENOS AYRES GAS WORKS.

THE following statement of the progress of Messrs. Bellhouse's contract for the Gas Works at Buenos Ayres, is taken from *El Ordern* (government paper), of the date, March 2, 1856, the day before the English mail left the city:—

"The gas company displays a remarkable activity. Already the mains are laid in a great number of streets, and in many others the trenches are ready for the pipes, which are laid along the sides of the footpath. The length of different sized mains already laid in the streets, and amounting to 6200 yards lineal, is as follows:—

1750	yards	12	inch pipes.
1450	„	9 & 6	„ „
2000	„	4	„ „
1000	„	3	„ „

The erection of the retort-house, coal-stores, purifying-house &c., is completed, except the iron roofs which are being proceeded with. One of the two large gasholder-tanks is entirely finished, the other will be completed in a few days. The retorts are upon the ground, and the furnaces are in a state of forwardness. If a mole had existed at this port, at which the lighters could discharge cargo on terrâ firmâ at once, instead of by means of carts, the works would have been in a more forward condition. Since December last, above 2000 tons of materials have arrived from England in ten vessels, and the delay in discharge of their cargoes is very considerable and troublesome. The gas company have contracted to supply the apparatus and gas for lighting the vast new theatre, now in course of erection, by means of 1200 burners."

Mr. W. Bragge, C.E., is the engineer for the company; and Messrs. E. T. Bellhouse & Co., of Manchester, are the contractors for the entire works.

Whistles for Locomotive Engines.—Locomotive engines should have two steam whistles, one a shrill one, the other a dull trumpet-like sound. All engines going say north, should blow the shrill one, those coming in opposite direction, always use the other. This would be a valuable preventive to collisions, especially during a snow storm, fog, or at night, or when feeling the road. Echoes from hills often mislead; persons approaching would know where to look for the train; those waiting at stations would be informed what train was approaching.

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INSTITUTION OF CIVIL ENGINEERS.

March 18.—ISAMBARD K. BRUNEL, Esq., Vice-President, in the Chair.

The paper read was "*On Improvements in Diving Dresses, and other Apparatus for working under Water.*" By WILLIAM HEINKE.

Passing cursorily over the somewhat doubtful accounts of the exploits of the pearl-fishers, even when aided by the primitive expedient of holding in the mouth a piece of sponge steeped in oil, and merely referring to the subaqueous labours of the ancients in their attempts to destroy the galleys besieging Tyre, and Syracuse, the Paper reviewed the various accounts of divers, and of such apparatus as had been described, down to the first distinct allusion to an apparatus called "an Aquatic Kettle,—stated by John Taisner to have been used by two Greeks, at Toledo, in Spain, in 1538. The same author mentioned "Aquatic Armour," which he preferred, as it enabled the divers to walk under water. The apparatus was evidently an open helmet, only calculated for small depths. Then came a series of inventions called "Air Chests," all, more or less, upon the same principle. In 1620 Cornelius Debrell contrived a submarine vessel in which the air was supposed to have been renewed by "a composition or liquid that would speedily restore to the troubled air, such a proportion of vital parts as would make it again, for a good while, fit for respiration."

Friar Bacon and Bishop Wilkins were both contrivers of diving apparatus, and the Marquis of Worcester, of course, included so inviting a subject among his list of inventions.

Borelli, in 1669, appeared to have made the nearest approach to a perfect diving dress, as he had a vessel of copper for the head, glazed in front, attached to a complete dress of goat's skin, and had a pump by his side, whereby he could cause himself to ascend, or descend at will; he had at the same time free communication with the air by means of pipes.

About the year 1575, propositions were made for submarine researches among the wrecked vessels, but most of the attempts were fruitless, in consequence of the imperfect apparatus employed; among the speculators was the Duke of Argyll, who employed one Colquhoun of Glasgow, to explore the wreck of a Spanish vessel sunk off the isle of Mull. The apparatus he used was very similar to the modern loose helmet, but it was only supplied with air, by tubes from the surface, without any pumps.

The most successful adventure of the period was undertaken by one Phipps, a ship carpenter, the son of a blacksmith, at Boston, in America. He devised some modification of the apparatus, which enabled him to operate in 1687, upon the wreck of a Spanish Galleon lying off the coast of Hispaniola; and on being assisted with money by the Earl of Albemarle, eventually succeeded in raising property of the value of 300,000*l*., of which his own share amounted to about 20,000*l*. He then continued to engage in similar ventures; so successfully that he was knighted, became sheriff of New England, and founded the noble family now represented by the Marquis of Normanby.

Dr. Halley, whilst Secretary of the Royal Society, paid great attention to the subject, and devised such schemes as would almost authorise his being considered the practical inventor of the diving-bell, and he certainly rendered the diving-dress more generally applicable. He first applied artificial means of supplying the divers with air by bellows, or by buckets alternately rising and descending. He stated, that he had remained at a depth of 10 fathoms for an hour and a-half without inconvenience. John Lethbridge, of Exeter, also introduced a diving chest with more success, in 1716. Leupold described several schemes, and Martin Treiwald in his apparatus, used convex lenses instead of plain glass for illuminating the machine. About 1750 Mr. Rowe introduced a diving chest, by means of which he appeared to have successfully explored several wrecks. Mr. Spalding and Mr. Farey, about 1775, introduced several useful modifications of Halley's and of Treiwald's apparatus. Mr. Bushnell, of Connecticut, in 1775 offered to destroy the British fleets then in the American waters; but though he could remain some time submerged, he could not succeed in his object. This scheme was resuscitated in 1822 by Colonel Samuel Colt the inventor of the celebrated revolver fire-arms; but although the government of the United States afforded considerable pecuniary assistance, it did not appear that any useful effect was arrived at. Mr. Day made a daring experiment in Plymouth Sound in 1774, when he prepared a submarine vessel, in whose qualities he had such reliance that he did not hesitate to sink with it in the deepest part, but never was heard of again Benjamin Martin, originally a plough-boy, in Surrey, but afterwards a celebrated optician, in London, introduced in 1778 several modifications, bringing the dress more towards the present form, and enabling it to contain a supply of air; his apparatus was used with considerable success in exploring wrecks.

In 1779, Smeaton first used diving-bells for civil engineering operations; and one of his apparatus was stated to be still in existence at Ramsgate harbour. Rennie employed them very extensively, and introduced great modifications in their construction, having them made of cast-iron with lenses in the top, and using powerful air-pumps. Very extensive submarine works were thus constructed, and difficult repairs were made. Telford also used the diving-bell somewhat extensively, and up to the present day Sir John Rennie, at Plymouth, and Mr. Walker, at Alderney and Dover and other places, had in common with almost all the other marine civil engineers, employed the diving-bell for their works. Indeed, the contractors for such works now found them so useful, and the men managed them so skilfully, that works heretofore considered almost impracticable were undertaken without hesitation.

About 1798, Kleingert, of Breslau, had a somewhat successful diving dress, and soon after Robert Fulton tried experiments on a submarine boat or diving chest, both in France and in America. At the commencement of the present century, Mr. Braithwaite, well known as a manufacturer of machinery, introduced several improvements in the construction of the diving-bell and pumps, and used them and the diving dress in submarine researches, recovering much property from wrecks; more especially from that of the *Abergavenny* East India ship, lost off Weymouth in 1804, in a depth of 10 fathoms.

The wreck of the *Royal George*, which occurred in 1782, afforded an attractive field for practical divers. Immediately after the occurrence, numerous propositions were made for attempts to weigh the ship. That of Mr. Tracey was selected, and although considerable expense was incurred, and every aid was afforded by the government, the attempts all resulted in failure, and the project was abandoned. The remains of the vessel having created a shoal in the anchorage, it was eventually determined to remove them; meanwhile Mr. Deane, who had for some years successfully practised diving, and had made many improvements in the dress and apparatus, having among other exploits, succeeded in 1828, in clearing the wreck of the *Curnbrae* East Indiaman lost off the back of the Isle of Wight, and that of H.M.S. *Boyne* off Southsea Castle, obtained permission to attempt operations upon the *Royal George*. His labours in 1834-5-6 were successful, so far as recovering many guns and stores, both from that vessel and from the *Mary Rose*, which had been submerged for nearly 300 years; but the final destruction of the wreck, and the removal of the shoal were effected under the directions of Colonel (now General Sir Charles W.) Pasley, between 1839 and 1843. This was done by placing cylinders heavily charged with gunpowder, alongside portions of the vessel, and firing them by means of the voltaic battery, the practicability of which had been previously demonstrated at the Institution of Civil Engineers on the 24th April, 1838, by Mr. J. Bethell, who also introduced, in 1835, many valuable improvements in diving dresses and apparatus. Mr. G. Hall was employed by Colonel Pasley, having with him a number of Sappers and Miners and other men, several of whom became very expert divers. In these works the dresses and pumps employed were principally made by Siebe, who under the instructions of Deane, had made great improvements in the diving-dress, and in other parts of the apparatus. The operations were successfully concluded in 1843, after exploding nearly 53,000 lb. of powder, the obstructions in the anchorage ground being entirely cleared away, and eighty-six guns, 582 cwt. of metal, and 59,000 cubic feet of timber, having been recovered. The experience acquired during these extended operations, had demonstrated the necessity for several improvements which were subsequently introduced by Siebe and other makers; the dress was made of better material and form,—was joined on to the helmet, which was made to go on with one-eighth of a revolution of the screw at the neck, the weights were better adjusted, and the eye pieces and air tubes were more conveniently arranged, whilst the pumps were so improved as to give ample supply of air to the men at considerably greater depths.

The Paper then proceeded to describe the modifications introduced by Mr. E. Heinke, the author's brother, and combined in the diving-dresses contributed to the Exhibitions in Hyde Park, in 1851, and at Paris, in 1855. Among the most important of these were the eye-frame, which had a slide so adapted to it that, in case of accidental fracture of the glass, the diver could immediately close it and prevent the influx of water;—a double valve fixed in the front of the gorget, by which the efflux of air could be so regulated as to enable the diver to ascend and descend at will; it had also been found that in case of the fracture of the eye-glass, by closing this valve the air issued through the glass, and the diver was enabled to come to the surface without risk. The connecting joints in the air-tubes were made with double-caps; and the tubes themselves were made sounder, more flexible, and much more durable. A signal dial was also introduced, by which the diver could make known his wants with certainty and rapidity; in fact the dress, with the large improved pumps, was adapted to the most difficult undertakings; as had been shown not only in the various submarine researches, but in the numerous works of civil engineering, in the execution of which the dress, with these improvements, was employed, and also in the comparative trials in the Seine, at Paris, in 1855, when, as an experiment, the diver wearing Mr. Heinke's dress, descended with a helmet, the front glass of which had been accidentally fractured at the works for the construction of Westminster new bridge; by managing the double valve, the diver was enabled to remain under water full half an hour, and, as was proved by examination, without admitting any water, as the inside of the dress was quite dry; the advantages of these arrangements were admitted by all the competitors at Paris, and a first-class medal was awarded to Mr. E. Heinke and also to Mr. Siebe for the several improvements they had introduced into diving apparatus generally.

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In the discussion, after exhibiting and describing the various modifications suggested by Deane, who generally used the open helmet, although, under certain circumstances, it had been found dangerous, the improvements introduced by Siebe and by Heinke were fully described. Both apparatus were spoken of as having been employed with complete success, although each system had, of course, its partizans. It was argued for instance, with respect to the double valve in the front, that it might cause a diver to ascend too rapidly through the water, and incur the risk of bursting the dress, or of striking the man's body against the bottom of the boat; but, on the other hand, it was shown that, by a judicious use of the valve, the diver could ascend as gradually as he wished to do, and in the case of a front glass being broken under water, at Westminster-bridge works, the man, by closing the valve, kept the water out of the dress and came safely to the surface; whereas, when in a submarine duel between two divers at Spithead, the glass of one of their helmets was fractured, there was considerable difficulty in hauling him to the surface sufficiently quick to safe his life.

Diving apparatus, when made like those exhibited, were spoken of as being now used with such facility that no dock, nor even any screw steam-vessel should be without them. They were now to be found on board almost all the large ships in the Royal Navy.

It was contended that the pressure, stated to be felt at considerable depths, could not exist, as the air being pumped in under a corresponding pressure, preserved the equilibrium. The ordinary outlet valve at the back of the helmet was a measure of precaution, but in conjunction with the front valve under the command of the diver, was admitted to be valuable.

An account was given of the proceedings in destroying the remains of the *Royal George*, in which Siebe's apparatus was chiefly used. It was argued, that the modifications mentioned were not improvements; but on the other hand it was contended, that everything must be an improvement, whereby the safety, the comfort, or the efficiency of the divers was augmented, and such was manifestly the result of the modifications of the ordinary apparatus introduced by Heinke, which had been exhibited and described.

April 1.—ROBERT STEPHENSON, Esq., M.P. President, in the Chair.

The discussion being renewed on Mr. Heinke's Paper, it was observed, that the name of Mr. Abbinet had not been mentioned among those who had used diving dresses; this omission should be repaired, as Mr. Abbinet was one of the early divers; he had made some very successful submarine researches in Vigo Bay and other places, and, subsequently, in conjunction with Deane, had cleared away the wreck of the *Boyne*.

Another omission was, not mentioning the extensive use now making of the diving dress in the construction of the piers at Portland breakwater, under Mr. Rendel; the water there being very clear, the divers work with great ease and certainty.

Numerous diagrams were exhibited of the various improvements introduced by Mr. J. Bethell; and it was stated that, in consequence of the occurrence of so many accidents to divers when using the open helmet, his attention had been directed to the subject, and he, in 1834-5, devised the tight closed dress, attached to the helmet, and joined together at the waist by a brass girdle and screws, causing the air to escape from it by means of a ventilating pipe from the top of the helmet, so as to get rid of all the respired and foul air, and thus keeping the diver constantly supplied with pure air. In 1836-7 and following years, many of these dresses were in use in Great Britain, and they were sent to Egypt, to the East, and West Indies, the pearl fisheries of Ceylon, the Bay of Navarino, and to many other places abroad, and although nearly all these dresses were used by men almost inexperienced in diving, yet no accident had ever occurred.

They had also been applied to many purposes besides recovering sunken property, and amongst others to the repairing of ships afloat. With one of these dresses, in 1837, H.M. ship *Thunder* was perfectly repaired at Nassau, in the Bahama islands, and was enabled to be brought home in safety; whereas, but for the facilities afforded by this dress, enabling a diver to work upon the hull under water, the vessel must have been broken up, as there were no other means of repairing her in that locality.

In 1838, H.M. ship *Wellesley*, of 120 guns, in entering the harbour of Trincomalee, sustained such severe injuries from striking upon a rock that she was on the point of sinking, when, by means of the closed diving dress, although the ship was in 20 fathoms water, in twenty minutes the leaks were stopped, and the ship was sufficiently repaired to continue her voyage.

There were also exhibited several drawings, showing how dock walls and stone piers could be built and repaired under water, by using the diving dress, and rocks could be blasted with gunpowder, fired either by the fuse in the ordinary manner, or by means of the galvanic apparatus, as was described by Mr. Bethell at a meeting of the Institution in April, 1838. By this system the fractured masses of stone or rocks were removed by being suspended beneath a common row-boat, and could be dropped in deep water out of the way of shipping.

Explanations were also given of Mr. Bethell's "Marine Telescope," by means of which a person in a boat above could see even at a depth of 30 or 40 fathoms of moderately clear water, all good sized objects, and could survey the ground at the bottom of the sea. An apparatus, somewhat similar to a hydrostatic press fixed on a large ship, was also shown, as adapted for raising sunken ships, or heavy weights, where there was no rise of tide to lift up the vessel used for weighing the wreck.

It appeared evident that submarine engineering works could be most materially aided by more general use of the close dresses, as a man could work in them for almost any length of time, in consequence of the great purity of air breathed. The diver thus always felt comfortable whilst below, and could easily remain for four or five hours under water; whereas, in helmets not fitted with this ventilating pipe, the foul air was apt to collect in the top of the helmet, and sometimes it was painfully felt by the diver.

It was stated that, about fifteen years ago, one of Mr. Bethell's close dresses was being used with safety in the bay of Navarino, although in 150 fathoms of water, when another ship came out there with a dress with an open helmet, and unprovided with a ventilating pipe; the diver descended in it, and unluckily lost his life. On examination into the accident, the body was stated to present all the appearances of a person who had died from suffocation.

Reference was made to several Papers connected with the subject read at the Institution. The first was on April 10, 1838, by Colonel Pasley, "On the Application of Bickford's Fuses for Blasting under Water," in which that system was exclusively recommended for submarine blasting. In the discussion upon that Paper, Mr. Bethell mentioned the experiments he had tried on the ignition of powder by the voltaic pile; he was requested to give an account of them at the next meeting, which request he complied with on April 24, 1838, exhibiting the experiments before the members at the meeting. It was then stated that Mr. Bethell's attention had been directed to the subject since 1834, whilst engaged on experiments connected with his diving dresses. The Paper went on to state:

"It is well known that when two ends of copper wires, leading from the poles of the battery, are connected by a piece of platinum, or iron-wire, the latter becomes red-hot. To apply this method, the top of the tin canister which contains the charge, is fitted with two copper wires about 6 inches long, passing through a piece of cork, and connected at their lower ends by a piece of platinum or iron-wire. The canister being charged, the platinum or iron-wire is pushed down into the middle of the charge, and the top of the canister cemented on with putty. The wires are well coated with a non-conducting medium, as a mixture of resin, wax, and tallow, or caoutchouc, excepting at their lower ends, where they are connected by the platinum, and at the upper, where they are to be connected with the two long copper wires which proceed to the battery. These connecting wires, covered with cotton thread, are coated with the caoutchouc varnish, and then tied together so as to form one rope; the diver having connected the wires of this rope with the wires of the canister, and uncoiled a sufficient length of rope, descends and deposits the canister in the wreck, or the hole prepared for the blast, and returns to the surface. The other ends of the wire are then dipped into the mercury cups of the galvanic battery, and the platinum wire becoming instantly red-hot, the charge is exploded. There is not more than about 6 inches of the wire rope lost at each discharge.

"The security, certainty, and convenience of this plan are evident. In quarries any number of charges could be fired at the same instant, or in rapid succession; and this method possesses incalculable advantages over every other for the military engineer, since any number of mines could be exploded at the precise moment that is desirable."

On the 16th March, 1839, some exeriments on firing gunpowder under water by the voltaic battery, were tried at the gun wharf at Chatham, under the direction of Colonel Pasley, and a report of the results was made to the Institution by Mr. F. Bramah, jun., and Mr. C. Manby, at the meeting of 19th March, 1839. The concluding words of that report were: "It is not necessary to describe the preparation of the connecting wires, or the manner of discharging the battery, as they are exactly the same as those detailed in Mr. Bethell's Paper read to the Institution last Session."—It appeared that the idea originated with Mr. Bethell, from reading an account of the experiments of Professor Hare, in America; it was found, however, that moisture in contact with the wires prevented the ignition of the powder; he, therefore, introduced the system of a waterproof covering, by which means the ignition could be effected from almost any distance. The merit of the introduction of the system of using the voltaic battery for the ignition of gunpowder in blasting under water, was claimed for Mr. Bethell.

This claim was contested, inasmuch as it was stated that Professor Daniell had mentioned the subject in his lectures at the Royal Institution long anterior to 1838; also that Colonel Pasley had his attention drawn to the applicability of the voltaic battery for exploding mines, by reading of a bridge having been so destroyed by an engineer officer in the Russian service, in presence of the Emperor; the precise date of this occurrence was not stated. At all events, to Colonel Pasley belonged the merit of the first application of the system on a large scale and in a practical form.

It was stated, also, that Colonel Pasley had suggested the use of the voltaic battery in 1835 for exploding the gunpowder intended to have been used in disrupting the ice of the Polar regions; this occurred in

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fitting out the *Terror*, under Captain Belcher, for one of the Polar voyages. The merit of the application had generally been ascribed by Colonel Pasley to Professor Daniell, from whose researches he had derived invaluable assistance. It was, however, objected that this was an application to submarine blasting, inasmuch as the ice would be quite dry.

Accounts of all the operations at the *Royal George* were published by Colonel Pasley in the 'United Service Journal,' and they would show what degree of merit he had claimed.

It was stated, that the firing of gunpowder across the Delaware river had been effected by Benjamin Franklin; this, however, was by the well-known means of the electric spark, and not by the use of the voltaic battery, so that the cases were not analogous.

At the conclusion of the discussion, which was announced to be resumed at the next meeting, it was observed that the improvements in diving-dresses, bells, and air-pumps, had contributed essentially to extending and facilitating the construction of engineering works in difficult situations, and Mr. Bethell, Mr. Siebe, and Mr. Heinke, might each, with justice, claim merit in these improvements, as might General Pasley for the attention he had devoted to the subject, and for the skill manifested in the practical use of the voltaic battery in the destruction of the wreck of the *Royal George*. The claim for priority of introduction could only be set at rest by reference to the exact dates, which the secretary was instructed to endeavour to obtain before the next meeting.

At the monthly ballot, the following candidates were duly elected:—J. Kitson, and J. Plews, as members; A. T. Cooke, W. Rosser, and F. W. Shields, as associates.

April 8.—ROBERT STEPHENSON, Esq., M.P., President, in the Chair.

The Paper read was "*On Steep Gradients of Railways, and the Locomotives employed.*" By CHARLES R. DRYSDALE, Assoc. Inst. C.E.

The object of the Paper, was to compare the results of some of the performances of locomotives of various construction, and of stationary steam-engines working ropes, and also the atmospheric system: to examine these results, and from them to determine the most economical and best manner of effecting the passage of mountain chains by railway lines.

A history of the construction of the Semmering and Giovi passes was first given, with the nature of the curves, gradients, &c. The locomotives of the Semmering and Giovi were then described. Some English steep inclines were then referred to, and the duties of the Semmering and Giovi engines were compared with the English engines for evaporating power, for horse-power per cubic foot of water evaporated, and for weight drawn in proportion to the weight of locomotive.

After this the duty of the stationary engine on the Edinburgh and Glasgow line was analysed, and the atmospheric incline on the St. Germain's railway.

The Semmering Railway.—A description was given of some of the most remarkable viaducts and tunnels of the line.

1. The viaduct of Kalte Rinne which was composed of two stages, with a gradient of 1 in 80, and a radius of 10 chains 600 feet long, with an extreme height of 150 feet.

2. The Wagner Graben viaduct had a gradient of 1 in 47; its length was 470 feet, and the greatest height was 127 feet.

3. The Semmering tunnel was 72 chains long; its greatest depth was 374 feet, lined with masonry. The length from Payerbach to Murzzuschleg was 21·52 miles, thus composed:—

	Miles.	Gradient.
Payerbach to Eichberg	3·84	of 1·46
Eichberg to Klamm	2·53	,, 1·40
Klamm to Breitenstein.....	3·26	,, 1·47
Breitenstein to Semmering ...	3·58	,, 1·54
Semmering to Spital	4·44	,, 1·50
Spital to Murzzuschleg	3·84	,, 1·50

The average gradient of Payerbach to the summit was 1·47 for 13·21 miles. The curvature was very great from Payerbach to Klamm; about 700 feet radius. The rails used weighed 88 lb. to the yard. The engines employed had 75 square feet of firebox surface; 189 tubes 2 inches diameter and 15 ft. 7 in. long = 1585 square feet heating surface, and 12·6 square feet of grate surface.

The weight of the engine filled and loaded, was 55¼ tons—13¼ tons on the leading wheels, 12¼ tons on the middle, and 13 tons on the driving wheels. Toothed wheels were afterwards added, and thus all the weight was brought to bear for adhesion. The diameter of the cylinders was 18·7 inches, the stroke 25 inches, and the diameter of wheels 3 ft. 7¾ in. Before the toothed wheels were added to connect the tender to the locomotive, the duty of the engine required by government, was to draw 110 tons up 1 in 40, at 10 miles an hour, consuming less than 144 cubic feet of dry wood per hour; to perform this, the load on the driving wheels must be at least eight times the tractive force required, as the condition of the Semmering rails gave no more friction available. Or 8 × 11,040 = 88,320 lb., nearly 40 tons, on the driving wheels was required. The resistance of 11,040 lb. was calculated from the gradient 1 in 40, giving 56 lb. per ton, due to the gravity, and the remaining 13 lb. was due to speed and traction on the level.

The performance of the engine before adding the toothed wheels was, on a gradient 1 in 40, dead weight = 110 tons, engine and tender = 55¼ tons. The water evaporated per hour (stoppages not included) = 255 cubic feet. The wood consumed to evaporate this = 3820 lb. The speed = 11·4 miles per hour.

1°. This gave 4·15 lb. of water evaporated per hour, by each pound of wood, or 9·6 lb. water evaporated per square foot of heating surface.

2°. As to the horse-power usually represented by the evaporation of 1 cubic foot water per hour, 165 tons (engine and tender included) at 11·4 miles per hour, drawn up 1 in 40, gave 347 h.p., and 255 cubic feet of water evaporated;—consequently, ·73 cubic foot evaporated was equivalent to one-horse power.

The "Mammoth," Great Western railway, = 0·76 cubic foot per h.p. per hour.

The Goods Engine No. 227, North-Western railway, = ·675 cubic foot per h.p. per hour.

3°. The proportion that the dead weight bore to the weight of the engine and tender, gave the following results:—

The Semmering engine, = 4·2 h.p. per ton of engine and tender.

The "Mammoth" = 3·2 h.p. per ton of engine and tender.

The North-Western No. 227 = 3·55 h.p. per ton of engine and tender.

These experiments were brought forward to show, that no engine in England would alone work the Semmering traffic. When the hinder wheels were connected with the others in the Semmering locomotive, the performance rose to 220 tons up 1 in 40, at 9½ miles per hour, giving with the engine and tender included a duty of 380-horse power; and 165 tons dead weight carried up by 55¼ tons of engine gave $\frac{285}{55{\cdot}25} = 5.2$ h.p. exerted per ton of engine and tender.

The mean pressure of steam was 80 lb.

Lastly, the economical effect stood thus:—44 lb. of water were evaporated, and 11 lb. wood were consumed per h.p. per hour including the engine and tender. Without these:—14·6 lb. of wood were consumed per horse-power per hour, giving: 14·6 to raise 33,000 × 60 lb., or 1 lb. of wood to raise 13,600 lb. a foot high; or again 82,208 lb. irrespective of speed.

The Giovi Incline.—On the Giovi incline passing the Appenines, near Genoa, on the Turin and Genoa railway, the engineer who introduced the working of this line by locomotives, had to contend against a strong party who were in favour of stationary engines.

The Giovi incline commenced at 7¾ miles from Genoa, 295 feet over the sea, and ascended for 6 miles to an elevation of 1184 feet. Average gradient 1 in 36; the length of tunnel = 2·55 miles; the depth of shaft = 600 feet; the cost per yard = 118*l*.

Two engines of the same size (built by Messrs. R. Stephenson and Co.), coupled together and managed by one driver, were used to work the incline. Each carried its own coke and water. The diameter of wheels = 3 ft. 6 in. The cylinders = 14 inches, with a stroke = 22 inches. The locomotives were bolted together with the fireboxes facing each other, and the driver stood on a common platform. Filled and loaded the two engines weighed 50 tons.

In fine weather the locomotives took up about 100 tons of load, and in the worst weather never less than 70 tons, at a speed of 15 miles per hour. The consumption of coke per ton per mile, amounted to, not including engine 1·94 lb.; including engine 1·16 lb. The consumption of coke, to draw the engine from the bottom to the top, 6 miles, of 1 in 36, was 8·27 cwt.

1°. The water evaporated per pound of coke, was 8·5 lb.

2°. 150 tons drawn up 1 in 36, at 15 miles per hour, gave a result, with the engine of 444-horse power; and without the engine 295-horse power.

3°. This gave 5·9 tons raised per ton of engine.

4°. 9·7 lb. coke raised 1,980,000 lb

Or 1 lb. coke 204,000 lb. 1 foot high.

Or, irrespective of speed 169,600 lb.

The *Accrington incline* was 1 in 41·6 for 2 miles. 71·6 tons were raised at 6·31 miles per hour up the incline. The engine had cylinders 18 inches diameter, 24 inches stroke, 6 coupled-wheels of 5 feet diameter.

The weight of the engine = 26·25 tons; tender = 16·75 tons;—total = 43·00 tons. The work done = 74-horse power, which gave 1·7-horse power raised per ton of the engine and tender.

The *Lickey incline* had a gradient of 1 in 37, worked by goods-engines with cylinders 16 inches diameter and 24 inches stroke, and driving-wheels 5 feet diameter, and weighing 32 tons, with an assisting engine whose cylinders = 16 inches, and stroke of 24 inches, and driving-wheels of 4 feet diameter, weighing 35 tons; together = 67 tons. The results were that 240 tons were drawn up 1 in 37, at a speed of 6¼ miles per hour, giving 293-horse power, or 4·4-horse power exerted per ton of motor.

The *Edinburgh and Glasgow Incline.*—This incline was stated to be 1¼ mile long, with a gradient of 1 in 42. During a trial of 23 months, the miles run lifting trains were 21,250¼, and the number of ascents = 14,167.

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The number of carriages drawn up = 205,181.
The average gross weight per train = 86 tons.
The prime cost of the rope = 1094*l.*
The coal consumed per mile to lift this weight of 86 tons = 527 lb.
Cost of coal per mile = 11·195*d.*
The friction of the rope = $\frac{1}{7\frac{1}{2}}$ of its weight.
The cost of working the line, including the rope = 50·299*d.*

The performance was 86 tons drawn up 1 in 42 at 30 miles per hour, giving 452 h.p. To this was to be added 211 h.p. to move the rope; and 35 lb. of coal were expended per horse-power.

Secondly, without consideration of speed, 1 lb. of coal raised 45,700 lb. 1 foot high.

The incline was worked by a wire rope of 4⅛ inches, and on several occasions there had been 30 loaded carriages on each train, and goods' trains of 120 tons carried up without detention.

The total cost of working the incline for one year was 734*l.* 18*s.* against 3204*l.* 16*s.* for locomotives, giving a difference in favour of the stationary engine of 2460*l.* 18*s.* 9*d.*

The engines used on the line were probably not well adapted for the traffic, and indeed, for such short inclines, the benefit of the stationary engines was very doubtful; there seemed, however, to be some propriety in using them for the passage of long Alpine gradients, as a rope could be made to work a length of 6 miles, and thus steeper gradients might be adopted—even 1 in 25, avoiding thereby great expense in constructing viaducts, &c.

St. Germain's Atmospheric Railway.—The gradient at the St. Germain's incline was 1 in 33 for the distance of 50 chains, and the total length of the inclination was 1·46 miles, with an average gradient of 1 in 43.

From June 2 to August 18, 1855, the number of ascents = 1413; the weight of carriages lifted = 73,241 tons. The total cost of working, including tallow, engine-men, coal, water, &c. = 612*l.* 10*s.* The cost per mile of ascent = 5*s.* 9½*d.* The average weight raised per train = 51·8 tons. The cost of coal = 20*s.* per ton. Economically, leaving speed out of consideration, 1 lb. of coal raised 31,136 lb. 1 foot high.

The following summary of results was given:—

Semmering Locomotives.—Total h.p. exerted = 380 h.p.; to lift the train = 285 tons; h.p. per ton of motor = 5·2 tons. Economically (irrespective of speed), 1 lb. wood raised 82,208 lb. 1 foot high.

Giovi Locomotives.—Total h.p. exerted = 444 h.p., per ton of motor = 5·9 h.p., economically (irrespective of speed), 1 lb. coke raised 169,600 lb. 1 foot high.

Glasgow Stationary Engine.—Total h.p. to raise the train = 452 h.p., without the h p. to lift the rope, economically 1 lb. of slack raised 45,700 lb. 1 foot high, irrespective of speed.

St. Germain's Atmospheric System.—1 lb. coal raised 22,063 lb. 1 foot high, irrespective of speed.

These results, as compared with the alleged duty of the Cornish boiler, one million pounds 1 foot high, were still far below laboratory duties.

April 15.—ISAMBARD K. BRUNEL, Esq., Vice-President, in the Chair.

The discussion being renewed on Mr. Drysdale's Paper, was continued throughout the evening. It was stated that on the Oldham incline, 1½ mile in length, with a gradient of 1 in 27, a tank engine weighing about 27 tons, drew at the rate of 15 miles per hour, a train of nine loaded carriages weighing 50 tons. The dimensions of the engine were—leading-wheels, 3 ft. 6 in. diameter; driving-wheel (four coupled), 5 feet diameter; cylinders, 1 ft. 3 in. diameter; length of stroke, 2 feet.

It was argued that it was extremely difficult to establish any useful comparison between the working of various inclines, in consequence of the dissimilarity of conditions, of local circumstances, and of the different modes of keeping account of the expenses. That instead of affixing the limit of adhesion, as on the Semmering, at eight times the weight on the wheels, as compared with the force of the pull of the engine, it would be practicable to ascend much greater inclines with only five times the weight to the drag of the engine. That the Semmering engines could not be received as any improvement upon the construction of the engines employed ten years ago at the Lickey incline, where two small engines had been in the habit of drawing, up a gradient of 1 in 37, trains of 50 loaded wagons, weighing at least 250 tons, at a speed of 6½ miles per hour: therefore that one of these comparatively small light engines would be quite able to haul 165 tons over the Semmering incline, at a speed of 11 miles per hour.

Though it could not be denied that English railway engineers were formerly prejudiced against any steeper incline than 1 in 100, and had believed that gradients of 1 in 50 could only be worked by means of ropes, yet it must be remembered that fifteen years ago Halifax was approached by a gradient of 1 in 44, and that twenty-two passenger trains per day, besides goods trains, were, without difficulty, conveyed over that incline by locomotives. There was, therefore, nothing new in these steep inclines, nor in the manner of working them. It should also be mentioned, that the result of later experience went to prove, that it was more advantageous to rely on the locomotive than on any system of ropes. Not only had the latter system been abandoned on the Euston incline (London), and at Miles Platting incline (Manchester), but even at Oldham, where there was a gradient of 1 in 27 for 1¼ mile, the rope was taken away two years ago, and the traffic was now entirely dependent on locomotives.

It was urged, that as early as 1839-40 the Lickey incline had been freely ascended by locomotives conveying trains, without any break in the course; the conditions of the Lickey and of the Dainton inclines, situated on the course of the lines, were very different from those of terminal inclines, such as at Oldham, Halifax, Manchester, &c.

The sharp curves, of not more than 10 chains radius, on the Semmering, must be taken into consideration, as on a gradient of 1 in 42 they would materially influence the working of the engines, at even a moderate speed. The question was, whether it was necessary to have such heavy engines as those of the Engerth construction, or whether it was not more convenient and economical to work inclines by means of two coupled engines, as at the Giovi incline. The latter opinion was strongly contended for, as also that generally the inclines in England were worked better, cheaper, and more regularly than that of the Semmering. In the year 1833, locomotive engines frequently ascended the St. Helen's incline of 1 in 30, although the traffic was worked by means of ropes.

Particulars were given of some experiments made with an engine intended for the Santander and Alar railway, in Spain; from which it appeared that upon an inclined plain, at Sheffield, about 300 yards in length and rising 1 in 27, the engine drew up 23½ tons (exclusive of the tender) at a velocity of about 2¼ miles per hour. The same engine, when tried on the Lickey incline on a foggy day, with drizzling rain falling, took up in the first experiment a load of nearly 46 tons in six wagons, at an average rate of about 10 miles per hour, and in the second experiment 29¼ tons, in four wagons, at a mean velocity of 18½ miles per hour.

It was again insisted, that circumstances varied so much as to render comparison of working the inclines almost impossible. It was necessary either to have special experiments under special circumstances, or to have such a large number of experiments as to arrive at the truth, by taking the average of the results. It was evident that the load that could be hauled by an engine was in proportion to the weight that could be put upon the driving-wheels; but that was limited by circumstances.

In order to arrive at some idea of the relative advantage of employing one very powerful, or two less powerful engines, two engines of equal power were taken, their speed and pressure compared, and a similar load of 280 tons was placed behind each. It was thus found that the two engines, when coupled together, took both loads up the same incline in the same time that each had taken up the half-load separately. At Edge-hill, Liverpool, there were three inclines of 1 in 48, 1 in 90, and 1 in 56, respectively. These were still worked by ropes and stationary engines, because, being situated in tunnels, it was found that the condensation of the steam on the rails when locomotives were tried, so lessened the adhesion, that in these particular cases it almost amounted to an impossibility of carrying out that system.

The important point to consider was the amount of adhesion to be obtained; one-eighth the weight was contended to be a fair average, as under certain circumstances of weather, &c., it fell to one-tenth, or one-fifteenth. That point being determined, the rest was a question of the advantageous employment of steam and the construction of the engines themselves.

It was stated that the Paper should be received as a record of facts, brought by the author under the notice of the Institution, rather than with a view to establishing any particular ideas as to modes of working inclines.

It must be evident that the system of working the Giovi incline by two of Messrs. R. Stephenson and Co.'s coupled engines was decidedly better and more economical than the system of using such enormously heavy engines as those constructed from the Engerth design for working the Semmering incline. It was decidedly more economical, as well as more convenient, to be able to work an incline by merely coupling together the ordinary engines of the line, than to have engines constructed expressly for the duty of ascending steep gradients, and unfit for the other portions of the line. Besides, the injury to the permanent way by such enormously heavy engines must be considered; when comparing their duty with that of two engines, whose weight was so much better distributed.

Circumstances of climate would always affect adhesion;—in the fine dry cold climate of Norway, inclines could be advantageously worked; whereas in a London fog, or even with the ordinary moisture of a dewy night, the adhesion would be materially impaired.

Ropes had been generally superseded by locomotives, but it should not be rashly decided to abandoned them entirely, as there were situations were steep terminal gradients might still be advantageously worked by them; whereas it would be preferable, or even almost indispensable, to work the inclines in the course of a line by locomotive power. The difference between current and terminal inclines must always be considered. The facts observed and collected by the author would be found valuable as data, from whence every engineer would draw his own conclusions, and apply them so as to meet the peculiarity of his own case.

In conclusion it was urged that, with regard to adhesion, no *a priori* arguments should be relied on, but facts alone should be had recourse to, and these, it was asserted, would be found to give the power of adhesion

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as being from one-eighth to one-tenth of the weight on the wheels. It was thought to be of great importance that the question of the comparative economy of working inclines by locomotives or by ropes, should be clearly investigated. In hilly districts, if gradients of 1 in 20 could be worked with facility, the construction of many costly viaducts and other structures might be avoided; and, of course, the less the expense necessary to be incurred in the formation of any railway the greater chance was there of its being satisfactorily executed.

April 22.—The Paper read was "On the Junction of the Atlantic and Pacific Oceans, and the Practicability of a Ship Canal, without Locks, by the Valley of the Atrato," by F. M. Kelly, U.S., and which was brought again under discussion on the 29th. The proceedings of both evenings will be given entire in our next number.

ROYAL SCOTTISH SOCIETY OF ARTS.

"*Description and Drawing of a Railway Lighthouse Signal.*" By ANDREW CARRICK, Glasgow.—This invention consists of an iron column, 16 feet high, being set up at certain points along the line. A light is reflected from a circular opening near the top, and every passing engine sets wheels in motion, by which the light is alternately obscured and brightened very rapidly during ten minutes. The object is to warn the conductor of a train that, should he observe the light disturbed as above, he must be cautious in proceeding, as another train is only a short way ahead of him on the same rails.

"*On a Method of Preventing the Bursting or Straining of Watercocks during Frost.*" By ALEXANDER CLEUGH, Rawcliffe, Yorkshire.—In this Paper Mr. Cleugh gave the results of his experience of his invention, which, he stated, had not failed during the past winter. His method is to cast the plugs hollow, and to fill the space above the water-way with vulcanised india-rubber, as shown in the specimen exhibited, the elasticity of which allowed the water to expand in freezing, and thereby saved the cocks. He stated that he had taken out the plugs when the water in them was frozen, but never found one broken or strained in which this packing was placed; while the others, if frozen, were either broken or strained, so that part of the water escaped, and when the ice melted these cocks leaked, and generally had to be rebored, and have new plugs made for them.

EXHIBITION OF THE NATIONAL INSTITUTION OF FINE ARTS.

We have visited this ninth exhibition in the Portland Gallery, and, deeply interested as we are in our national progress in painting, as well as in that department of the fine arts which is our peculiar province—architecture, we could not help feeling some disappointment at what appeared the deficiency in merit of the majority of the works of this year, compared with those of the last exhibition. The architectural subjects are few in number—"The Crypt, Wells Cathedral," by Mr. S. Rayner, is a very effective picture. We were also much pleased with Mr. L. J. Wood's "Cathedral at Vire—Normandy."

Landscapes, as might be anticipated, largely predominate; the monotony being relieved by a few pleasing sketches of domestic life, and some studies of animals; but there is a striking absence of historical subjects, of which the exhibition last year was not deficient.

"James Watt, and the Steam Engine," by Mr. Lauder, life size, appears the most ambitious work in the collection. It exhibits the great inventor during his vigils in the workshop; the intense expression of countenance, anxiously watching the movements of the machinery, is excellent. The attitude is not quite what we could have wished, but the colouring of the picture is good.

Among the landscapes are some very meritorious works, particularly the productions of Messrs. G. A. Williams, S. R. Percy, W. Lukeing, T. G. Soper, A. F. Rolfe, and H. B. Willis.

NOTES OF THE MONTH.

The Society of Arts are holding their exhibition of inventions, and it is well worth a visit. Among the numerous collection is the moderator patent furnace, which "unites in one single action all the desiderata which the most competent writers on smoke-prevention have indicated as requisite to success." There are various valves and other safety-apparatus for steam-boilers—improved locomotives, pumps, locks, ships' compasses, boats, tents, and other novelties. Glass tiles and glass sash-bars. New omnibuses, one of which allows to each passenger a comfortable seat, where he may be at his ease, safe from pickpockets. There is the globotype-telegraph, delivering its messages by means of small coloured balls which run down inclined planes to a shelf, where they stand in a row to be read off. The process goes on at both ends of the line at the same time, without needles or registering-pencils, or complication; and until the balls are disturbed, there the message remains to be referred to, if needful. We shall more particularly refer to this exhibition next month.

The Secretaries of the British Association for the Advancement of Science have issued the usual annual circular, announcing the time appointed for the meeting of the present year. Members and their friends are invited to assemble at Cheltenham, under the presidency of Professor Danbeny, on Wednesday the 6th of August. The reception-room will be in the Rotunda, Montpelier. The sections will meet daily, from Thursday the 7th to Tuesday the 12th of August, inclusive.

The foundation stone of a new Catholic church was laid on the 25th of March, at the top of the Whitecroft, Sheffield, from designs of Messrs. Weightman, Hadfield, and Goldie, and is to consist of nave, aisles, and chancel, terminated by a ladye-chapel. The height of the nave will be 101 feet; chancel, 20 feet; height of nave from floor to ridge, 50 feet; height of tower, 95 feet. It is expected to be so far finished as to be used for divine service by Christmas.

In the church of St. John Baptist, Glastonbury, a stone pulpit, the gift of Lady Charlotte Neville Grenville, was used for the first time on Easter Sunday. It is of Painswick stone carved in six Gothic panels, each panel having two niches, and each niche a sculptured figure of one of the Apostles. The design was furnished by Mr. Scott, from parts of an old stone pulpit lately discovered in the church, and has been executed by Messrs. W. and F. Merick. The church is about to undergo a complete restoration.

Excavations have been made of late at Mayence, in the house which is said to have contained the first implements of Guttenberg. Beams belonging to a printing press, stones for grinding colour, and parts of a hearth under a vault, have been found, pointing to a confirmation of the belief, that Guttenberg practised typography first as a hidden and mysterious art.

The municipality of Munich have passed a resolution, that the graves of Sennefelder, inventor of lithography, and Gabelsberger, inventor of stenography, should remain unalienable property in perpetuity, as they convey the recollection of two great inventions of the human mind.—Two large stained windows have been exhibited in the royal glass-painting manufactory; they represent the sacrifice of Abraham, and the preaching of St. John, and have been ordered for Cambridge. They have been designed by pupils of Hess.

The place in the Champs Elysées scarcely vacated by the palace of the Industrial Exhibition, is already crowded with workmen to erect a new hippodrome for public recreation, as the old building, near the Barrière de l'Etoile, had to be demolished to make room for some improvements. The new hippodrome, projected on the largest scale, by the architect, M. Arnauld, will be surrounded by vast gardens, refreshment-rooms, &c.

The four colossal statues for the central roof of the new Museum, Berlin, representing Fortuna, Art, Prussia, and Peace, have been cast in zinc in the foundries of Devaranne, Fischer, &c. They will be coated with a varnish of grit-stone colour. The relievo for the pediment, by Professor Kiss, will be cast by M. Geiss. The porticoes will consist of square, and forty-five Doric columns, forming three passages. The ceiling will be of masonry in the form of *cassettes*, and ornamented by stucco-work. The floor will consist of large granite slabs, and the roof be covered with zinc.

At a meeting of the Rhineland Society of Bonn, Dr. Marquart, in alluding to the subject of platinised coal, for absorbing gases and the purification of air, said that coal will powerfully absorb carbonic acid gases, but did not condense enough of oxygen to effect their perfect destruction or absorption. Coal is inferior in this respect to finely-divided platinum. But experiments have been made of late to form a compound of platinum and coal, which combines the properties of both, and where the degree of the action of the former may be graduated *ad libitum*. A compound of coal with 2 per cent. platinum will be sufficient, if the preparation be intended for purification of air. But an addition of 9 or 10 per cent. of platinum increased these qualities, and augmented the power of oxidisation to that degree, that if hydrogen gas or the vapours of alcohol be conducted over coal thus prepared, it will cause its ignition.

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THE METROPOLITAN BOARD OF WORKS.

As may be supposed, we entertain a very deep interest in the operations of the Metropolitan Board of Works, the members of which, we are fully aware, have some highly important duties to perform, involving matters of the greatest moment, tending to the general improvement of our vast metropolis. We need scarcely, therefore, remark that we shall always be most ready to report, from time to time, and offer suggestions in reference to, all projects enunciated by the Board, which come within the scope of our *Journal*, upon all those particular subjects that may have in view the amelioration of our fellow-citizens, and the improvement of our city and its multitudinous ramifications.

At a meeting of the Board, held in the Council Chamber of the Guildhall, on the 25th of March last, Mr. D'Iffanger brought forward a motion in reference to the "nomenclature of streets, to the effect that where *more than one street in the metropolis is called by the same name, to alter the name of any and all such streets except one.*" In moving the resolution, Mr. D'Iffanger said "that the evil was not so great in *High-street* and *North-street* as it was in many places, but there was a great evil arising from people not knowing that there were other streets of the same name. The present nomenclature of the streets was inexplicable. There was a street in one continuous line, situate in the three parishes of Paddington, Marylebone, and St. Pancras; it had the following names:—Seymour-street, Upper Seymour-street, and Lower Seymour-street. Then there was Wigmore-street, Mortimer-street, Charles-street, and Goodge-street, all in a line. On different sides of the way along the same street there were different names. In the Edgware-road, the line was now so called, and then some place (in the same line of street) intervened, and then it was called Edgware-road again." These, however are only a few of the innumerable anomalies and tautological enumerations arising from the present absurd manner of naming our streets, which causes an inconceivable amount of real inconvenience. The mover of the motion alluded to, quoted the following letter from Mr. T. Cook, an intelligent inspector of letter-carriers, addressed to Mr. Rowland Hill, to show the great trouble which it occasions in the delivery of letters.

"*General Post-office*, Dec. 27, 1854.

SIR—Having been informed by Mr. Watson that you desired me to make a statement of whatever I might know detrimental to the proper delivery of letters, I respectfully beg to submit the following remarks:—

Not only the delivery, but the sorting, is retarded by the irregularities connected with the building of houses, &c., in various parts of London.

First. The number of alleys and courts having houses without numbers, or badly numbered, occupy the time of the letter-carriers so long, that the delivery of important letters in the neighbourhood is frequently delayed.

Secondly. The distinguishing streets of the same name by Great, Little, Lower, Old, New, East, West, &c., is very objectionable, omissions and mistakes being sometimes made by having such words prefixed.

Thirdly. A great number of streets of the same name, and sometimes in the same parish or locality—such as King-street, Queen-street, John-street, William-street, New-street, &c. If reference be made to a book of streets, there will be found about 50 King-streets, nearly as many Queen-streets, above 60 John-streets, 60 William-streets, and upwards of 40 New-streets, with various other places in similar proportions. The latter name is likely to mislead strangers, who may suppose such streets to be of recent construction. In course of time, like all other things, these streets become old, but still retain the name of New, whilst their appearance indicates them to be quite the reverse. Such names are inapposite, and should therefore never be given to any places.

Fourthly. The irregularity in the numbering of houses is one of the greatest hindrances to the delivery of letters, and should be remedied as soon as possible, not only for official purposes, but also for the benefit of the public, who frequently suffer great inconvenience by the delay or non-delivery of letters, which otherwise would have reached the persons for whom they were addressed.

These irregular numbers may generally be traced to the following causes:—In the construction of new streets, the building of houses may commence at both ends, and on each side, at the same time. The four corner houses are sometimes all called number one. The other parts of the street may be afterwards built by different persons, who now can give to their houses whatever names they may think proper. One may prefer Albert-terrace; another Wellington-place; and a third, wishing to preserve the family name, will call his houses Smith's, Taylor's, or Bacon's cottages, as the case may be. Each set of houses having a number one, will cause seven houses in the same street of the same number. Irregular numbers are also sometimes occasioned by the carelessness or ignorance of the persons who inhabit the houses; an instance of which came under my notice while going round with a letter-carrier to survey one of the districts in the eastern part of London. On arriving at a house in the middle of a street, I observed a brass number (No. 95) on the door, the houses on each side being numbered respectively 14 and 16. A woman came to the door, when I requested to be informed why 95 should appear between 14 and 16. She said it was the number of a house she formerly lived at in another street; and it (meaning the brass plate) being a very good one, she thought it would do for her present residence as well as any other.

If the removal of such anomalies could be effected, there can be no doubt the service, and the public generally, would be materially benefited.—I am, &c.

(Signed) T. B. COOK."

In addition to the above, we may also state, in illustration of our subject, that Mr. Henry Mayhew, in his recent work, 'The Great World of London,' enumerates "not less than 89 localities called York, 58 Gloucester, 44 Brunswick, 39 Bedford," with an innumerable host of others named after aristocratic personages. "Next, in illustration of *hero-worship*, there are 52 thoroughfares called after Wellington, 29 after Marlborough, and 11 after Nelson, 20 styled Waterloo, and 15 Trafalgar. There are 58 localities called George, 40 Victoria, 43 Albert, 49 Charles, 35 James, 33 Edward, 30 Alfred, and 20 Charlotte. Further, we have a considerable number named after the *cardinal points* of the compass, there being as many as 48 denominated North, not a few of which lie in a wholly different direction, and 44 bearing the title of South; whilst there are 29 nicknamed East, and an equal number West." Taking the above list, therefore, into consideration, which, however, does not contain a tythe of the tautology employed in the naming of our thoroughfares, squares, places, &c., it is not to be wondered at that the Post-Office officials experience such difficulty in the conveyance of letters and other communications to their correct places of destination; neither can we feel surprised at strangers from the provinces and foreigners meeting with great obstacles in navigating the intricacies of overgrown London. It is hoped, therefore, that the Metropolitan Board will give the matter that careful attention which has distinguished their labours on all subjects that have already come under deliberation. In addition to the numerous repetitions of the same name, which has been carried to such a ridiculous extent, it will scarcely be credited that, such has been the negligence of the street commissioners in this respect, that there are numbers of places which actually have no names whatever affixed to them; and we could point out one fashionable square in particular, that, although it has no less than five thoroughfares leading into it, and consequently contains ten external angles, not one of these has the name of the square painted on it. Then, again, in very many instances where the names have been affixed to, or painted on, the corners of the streets, they have been covered up with boards announcing "Chambers to let," or with huge glaring sign-boards holding forth that "Barclay and Perkins', or Meux's entire" is to be had within.

Whilst upon this subject, in addition to dispensing with superfluous repetitions, it is deemed highly desirable that the nomenclature of the streets should be prominently set forth on pieces of slate, painted with white letters on a dark blue ground, and fixed conspicuously at all the external angles of every thoroughfare, and not allowed to be covered up, or to be either nearly or entirely obliterated, as is very frequently the case.

It is further recommended that, where it is not the case at present, a lamp-post should be fixed at the corner of each street and square, having the name painted on the glass or otherwise displayed, so that it could be readily distinguished by night as well as by day, which would be a great assistance, not only to strangers, but also to cabmen and others in finding out particular localities. The lamps should also have the numbers of the door to which they are nearest opposite painted on them, which has been previously suggested. Further, we beg to throw out another suggestion regarding the use to which street-lamps might be made available, which is that their distance from a given central point—say St. Paul's—should be prominently registered upon them, taking a circle of 3, 6, or 10 miles, adopting as a matter of course those lamps only which are situated at the most convenient points, making the intervals of measurement not less than a quarter of a mile. By this mode, it is believed that distances might be readily calculated with some degree of accuracy, of which at present, in many instances, we have but a very vague conception. This indication, together with the exact localities of all the branch post-offices, being displayed on the street-lamps in a similar manner, would, we trust, be found a

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great public convenience; for, according to the very imperfect way in which they are at present arranged, the posting of letters, particularly by strangers, in town, is often attended with much trouble: we should advise that, in this case, the lamps be made of quite a different design to those now in use, adopting coloured glass as at present employed by apothecaries over their doors, the lamps being, of course, of a different form and colour, but to be perfectly uniform; the distance lamps being of one design, the post-office another, and the ordinary street-lamps to remain as they are, so that each, individually, might be readily distinguished.

Drainage of the Districts South of the Thames.

April 4.—At the meeting of the Board on the 4th April, Mr. BAZALGETTE, the chief engineer, read his report on the sewage interception, and main drainage of the districts south of the Thames. In the plan now submitted, the objects sought to be obtained were two fold and distinct,—first, to provide improved outfalls for the drainage of the entire area; and, secondly, by a system of interception to relieve the Thames from the pollution to which it is now subjected. Some of the sewers proposed are designed to serve the double purpose of draining and interception, while others are simply "intercepting sewers," and do not of themselves drain the district through which they pass, but merely supply artificial channels by which the sewage is diverted from the drainage sewers and carried away to a new and less objectionable point of discharge into the river.

The estimated cost of the works herein recommended will be as follows:—

High Level Sewer, from Clapham to Deptford and Branch	£199,226
Extension from Deptford to Plumstead	155,550
Low Level Sewer, from Putney to Deptford and Branch	209,000
Reservoir and Land for Pumping Stations	103,140
Engine-houses, Engines, Pumps, &c.	164,780
Total	£831,696

Mr. Bazalgette expressed his full confidence in the soundness of the leading principles of the design, continued as they were by the experience of others as well as his own.

Mr. CARPMAEL moved that the report be received, printed, and circulated among the members of the Board, together with the estimates accompanying it. This proposition being seconded by Mr. DOULTON, was unanimously agreed to.

Embankment of the Thames.

A letter was read from Mr. Lionel Gisborne, of Duke-street, Adelphi, forwarding to the Board certain documents connected with a plan for improving the state of the Thames by embanking it (as it was understood) on both sides, between Westminster and London bridges, which he was desirous of bringing under their consideration.

Mr. Deputy HARRISON said, he understood the plan of Mr. Gisborne was one for embanking the Thames on both sides, between Westminster and London bridges. The government, he understood, had decided that they would not entertain or support that plan, or, indeed, any plan for the improvement of the metropolis which had not been first submitted to and approved by this Board. It was, therefore, incumbent on the Board to examine into the merits of plans for the improvement of this city, come from whom or from what quarter they might, since the government had thrown on them that additional responsibility. The conception of embanking the Thames was in the highest degree important and deserving their serious consideration.

Mr. WRIGHT having moved that the matter be referred to the committee of works and improvements, it was put to the vote and carried.

Street Nomenclature.

Mr. D'IVERNOIS, pursuant to notice, brought forward a motion with a view of altering the nomenclature of the streets of the metropolis, which on the suggestions of Mr. LESLIE and Mr. H. L. TAYLOR, was referred to the Committee of Conference.

Improvement of Holborn-hill and Skinner-street.

Mr. T. H. HALL, pursuant to notice, moved:—"That it be referred to the Improvement Committee to consider and report to this Board whether any alteration ought to be made in the level between Holborn-hill and Skinner-street, before the corporation commence letting their vacant ground on building leases, it being apparent from the state of forwardness of Victoria-street that no time should be lost in coming to a decision on this long-needed improvement."

The motion was seconded by Mr. COLLINSON, and agreed to.

Cash Account.

The cash account of the Board on the 31st of March last showed a total general balance in favour of the Board, at the Bank of England and the Bank of London, of 169,444*l.* 14*s.* 5*d.*

New Street from the Borough to the West End.

April 11.—The next fortnightly meeting was held on this date, upon which occasion a deputation of the parishioners of St. Saviour's, Southwark, urged the necessity of proceeding with the new street from the Borough to the West End, strengthening their application with the facts that there was now the sum of 85,900*l.* in hand for the prosecution of the works, and that Sir Benjamin Hall was highly favourable to the project. They submitted that the immense traffic from the increase of population, and from the fact of Southwark-bridge not being open to the public without toll, and also consequent on the termini of the three great railways—the South-Eastern and London and South Coast at London-bridge, and the South-Western in the Waterloo-road—rendered a new street absolutely necessary, and the first of the public metropolitan improvements that should be undertaken by the Board, and without any delay, as otherwise the benefit of the 85,900*l.* appropriated for the purpose might be lost. They added, that such improvement would have the hearty support of the Chief Commissioner of Works.

The Thames Embankment.

Mr. WILKINSON presented a memorial from Mr. Edward Loder, of Cambridge-terrace, Hyde-park, and others, which stated that they were the promoters of an undertaking called "The Thames Embankment and Railway," the objects of which were—first, the formation of an embankment and works, including certain "floating" and tidal docks on the north side of the river Thames, between Southwark and Westminster bridges; secondly, the construction a public road and footways, to be carried on a viaduct along that portion of the embankment between Whitehall-place, near Charing-cross and Chatham-place, Blackfriars, having also communications with certain streets leading out of the Strand; thirdly, the laying down of a railway within the line of embankment, from Queenhithe, near Southwark-bridge, to Manchester-buildings, adjoining Westminster-bridge, with an extension line to the Greycoat hospital, near the new Victoria-street, to join the "Westminster Terminus" railway. The memorialists also stated they had at the present time a bill pending before Parliament for the above purposes, which, if authorised, would enable them to confer on the public the following advantages:—first, an improvement of the river Thames; secondly, great sanitary benefits; thirdly, a much required new road between Charing-cross and the city; fourthly, an expeditious, cheap, and, in all weathers, certain mode of inter-communication by rail between the heart of London and the west-end; and, fifthly, extensive relief to the present thoroughfares by the conveyance direct from the numerous wharves to the various railways round London, of an enormous amount of heavy goods traffic at present carted through the streets of the metropolis. They were prepared to show that all the foregoing advantages could be secured to the public by the carrying out of their plan, without the infliction of injury on or inconvenience to any interests or individuals, and at a cost which brought the whole undertaking within a very moderate compass. The plans had been submitted in detail to the various public departments interested in the questions at issue, but the promoters had been referred to this Board as the only competent authority to investigate and pronounce an opinion upon the question as a whole, and on the benefits or otherwise to be derived by the public from the concession of the powers sought to be obtained. The memorialists entertained a strong conviction that the undertaking would be commercially valuable and self-supporting, and could be carried into execution without any expenditure of the public funds.

Mr. DAVIS called the attention of the Board to the fact that the inhabitants of Plumstead and Woolwich felt great alarm at the proposal to make that vicinity the point of outfall into the Thames, of the whole sewerage generated on the south side of the river; and, after his motion on the subject, that Mr. Bazalgette's report be sent to each District Board, the meeting adjourned.

Assessment of the Metropolis.

Mr. SEELEY, pursuant to notice, moved—"That in order to make provision for the proper carrying into effect the 144th clause of the Metropolis Local Management Act, it be referred to the Finance Committee to prepare and lay before this Board an estimate of the several sums which it will be necessary yearly to assess upon each parish or district in this metropolis, in order to realise a stated income of 100,000*l.* per annum, to be applied to the purposes described in the said 144th clause. And also an estimate of the rate which will be required to raise such sum, supposing that the whole metropolis be rated in one and the same proportion."

The motion was seconded by Mr. BRISCOWE, and, after a short discussion, agreed to, with some slight modification.

Private Gates in the Metropolis.

Mr. NICHOLAY, in pursuance of notice, moved a resolution to the effect that, in order to carry out the intention of the Act for the Better Local Management of the Metropolis, whereby improvement in the thoroughfares was contemplated, the clerks of vestries and district boards be requested to furnish the Board with a return of all gates and obstructions which interfered with the general convenience of the public. The hon. member explained that his motion had reference to what were called private gates, such as those on the Bedford, Southampton, and Grosvenor estates, and especially those in Belgravia, which he regarded as so many remnants of feudal times.

Mr. CORRIE rose to order, contending that the hon. member was asking the Board to do an act which would be an interference with private rights, and which, therefore, it was not within the scope of their powers to carry into effect.

The CHAIRMAN explained that by the 107th section of the Act for the Better Management of the Metropolis, the Board was precluded from interfering with private rights of the nature of those sought to be effected by the motion of Mr. Nicholay. Besides, he added, the preamble of the motion was incorrect, inasmuch as it was not the intention of the Act to do away with those gates.

Mr. NICHOLAY, on that expression of opinion from the chair, withdrew his motion.

The City Sewers.

Mr. BURSLEM called the attention of the Board to a circular-letter of Mr. Woolrych, the clerk to the Board, in which that gentleman explained in some detail his opinion as to the powers of the Board under the Metropolis Management Act, in relation to sewers to be built within the limits of the city of London. As the question was one on which a diversity of opinion was likely to prevail, the hon. member moved that the opinion of the Attorney and Solicitor General be taken in reference to it. The city members protested against any such reference to the Attorney and Solicitor General, as there was no intention on the part of the corporation to interfere with the powers of the Board in relation to sewers built within the limits of the city, and deprecated the Board rushing into litigation on a question which, in all probability, would never be raised. The subject gave rise to a long discussion, which ended in the withdrawal of both the original motion and an amendment moved by Mr. Wilkinson for modifying it, Mr. Bursiem stating that his object in mooting the question had been attained.

April 18.—Mr. WOOLRYCH read the minutes of the last meeting, which were duly certified.

Cash Account.

Mr. HATTON, the clerk of the accounts, reported the financial statement of the Board. It was as follows:—

BANK OF LONDON.					
Balance in hands of treasurer April 14, 1856 ..	£12,825	3	5		
Cheques drawn, but not presented	593	2	5		
Available balance..	11,732	1	0		
Amount of deposit account	20,000	0	0		
				31,732	1 0
BANK OF ENGLAND.					
Amount of Exchequer Bills deposited	£139,500	0	0		
Cash balance in hand April 14	967	9	11		
				140,467	9 11
Total general balance				£172,199	10 11

The application of Mr. HEMMING for the approval of a temporary church for Newington, was agreed to.

Proposed Thoroughfares through the Metropolis and St. James's and Hyde Parks.

Mr. BURSLEM called the attention of the members of the Board to a communication from Mr. Alfred Beaumont, containing suggestions "for thoroughfares through the metropolis and St. James's and Hyde Parks." The applicant in his memorial stated, "that the attention of the government and the Commissioners of the Board of Works being now occupied in re-considering this subject, he was anxious to bring forward his original suggestions, with two others for similar improvements in Hyde Park, and along the north bank of the Thames." The design of Mr. Beaumont, as to improvements in Hyde Park, &c., is to add new wings, forming decorated screens of columns to the arch at Constitution-hill. The central portion is intended to be used as the Queen's private entrance; the east wing for the public into the Green Park; and the west carried across Grosvenor-place and adjoining the hospital—to make this side correspond with the opposite entrance into Hyde Park. The marble arch Mr. Beaumont proposes to remove bodily 200 yards in front of Buckingham Palace, at the junction of a road about the third avenue of the Park mall; the space forming a semicircle between this and the Palace, to be enclosed with balustrading, and a sunken area decorated with sculpture. In the centre of this enclosure, to place the statue of George the Fourth, and in the front to erect a fountain and spacious basin. In a direct line from this it is intended to continue the avenue up to Charing-cross, and obtain a new and striking entrance into the Park, adjacent to the statue of Charles the First. Mr. Beaumont also suggests the appointment of a more direct road from the north to the south side of

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Hyde Park, in lieu of the route by Park-lane, by which he states the distance between the Victoria and Prince of Wales's gates would be shortened at least a mile and a-half. He also suggests another line from the Bayswater-road to the bridge, namely, along the boundary-wall of the gardens. That would only require the trench to be widened for a road, he states; and if the two projecting bastions were cut through, and a light fence along the east side along the sloping bank were erected, he believes it would be a great advantage, especially if the entrance to the gardens at the north-east corner were carried over a small bridge, so that the road might meet the Bayswater-road on its present level, near the new gateway. He also proposes a quay, or ornamental embankment, along the northern shore of the Thames, to commence, at its western extremity, on the south side of the Thames, forming a continuation of the street south of St. Martin's Church, till it reaches the river. It is then carried along the line of its north bank, adopting the level of the several bridges as it passes them, and terminates at New Cannon-street, at its present level. It is also proposed to pass over Southwark-bridge, by the addition of side-paths, and, if needful, along the south side of the river by a similar quay, terminating with a street communicating with High-street, and nearly opposite the South-Eastern terminus.

Mr. Austin's Plan for the Discharge of Sewage into the River Thames.

April 25.—Mr. Austin, who has communicated to us his plan, laid before the Board on the above date, suggests the construction of two under-shore tunnels or conduits, at about 20 feet below the mud level; one on each side or bank of the river, and extending from above Battersea to below Barking creek; each about 20 miles in length and of sufficient capacity to carry off double or treble the present quantity of sewage. At the lower terminus of each tunnel a reservoir is to be constructed into which the whole of the sewage would be lifted by pumps, revolving floats, buckets, or other contrivance, worked by powerful steam machinery. The sewage there to undergo the process of deodorisation, and to be formed into blocks or pulverised for agricultural purposes. The liquid portion would be discharged from the reservoirs into the Thames at ebb-tide in a clear and limpid state free from stench, or it could be run through supply pipes into the surrounding country as an irrigator; the liquid, although clear, possessing highly fertilising properties after deodorisation.

Independently of the advantages of preventing the flow of sewage into the river, by conducting it through the under-shore tunnels, the tunnels themselves would form the foundations of limit walls or river boundaries, proposed to extend from London Bridge to Battersea; by which arrangement the filthy and malarious mud banks would be got rid of, and handsome wharves, piers, docks, jetties, and promenades be constructed in their stead, preventing the now frequent overflow at high tides, and allowing sufficient depth of water for steamboats, barges, &c. to load or unload at high or low water on both sides of the river. The proposed width of the Thames above London Bridge would average 750 feet.

NEW PATENTS.

PROVISIONAL PROTECTIONS GRANTED UNDER THE PATENT LAWS AMENDMENT ACT.

Dated December 22, 1855.

2899. J. Gedge, Wellington-street, South Strand—Improvements in cutting and folding paper to form letters or notes and envelopes in one piece. (Communication from G. Pierre, Clichy la Garenne, France)

Dated January 21, 1856.

164. G. A. Blittkowski, New York, U. S.—Improvements in repeating fire-arms

Dated January 23.

181. J. Hopkinson, jun., Huddersfield—Improvements in apparatus connected with steam boilers

Dated January 24.

195. J. A. Longridge, Flndyer-street, Westminster—Improvements in the construction of ordnance and other vessels intended to resist internal pressure, and in the manufacture and method of discharging projectiles

Dated January 25.

201. G. G. Woodward, Kidderminster—Improvements in the manufacture of carpets

Dated January 28.

228. H. Hilliard, Glasgow—Improvements in articles of cutlery, and in apparatus for sharpening and cleaning the same

Dated February 1.

277. P. A. Lecomte de Fontainemoreau, Rue de l'Echiquier, Paris—Improvements in the saponification of fatty matters. (Communication)

Dated February 2.

291. G. Napier, Bath-street, Glasgow—Improvements in breaks for railway and other carriages

Dated February 8.

337. T. Restell, New Kent-road, Surrey—Improvements in breech-loading and revolving fire-arms and in cartridges

Dated February 13.

363. J. Mills, Oldham, Lancaster—Improvements in the slide valves of steam-engines

Dated February 14.

377. J. C. Meyer, Paris—Improvements in machinery for rolling metal

Dated February 20.

436. D. Auld, and J. Stephen, Glasgow—Improvements in steam-boilers and furnaces and in apparatus connected therewith, and in the consumption or prevention of smoke

Dated February 21.

447. J. D. Greene, Craven-street, Westminster—An improvement in breech-loading fire-arms

Dated February 22.

458. W. Strang, Glasgow—Improvements in ornamental weaving

Dated February 25.

475. B. J. Heywood, Dublin—Improved holder for leads, slate, and other marking materials, applicable also as a case for other articles

477. J. Murgatroyd, Heaton Norris, Lancaster—Improvements in steam-boilers

479. C. Iles, Birmingham—Improvements in pointing hair-pins, and in making up hair-pins for sale

483. J. Marzolo, Padua—An impressible mechanism, reproductive of movements and applicable to weaving and other looms, and for industrial purposes

Dated February 26.

485. J. Barrow, jun., Manchester—Improvements in the manufacture of soda, sulphurous and sulphuric acids, carbonic acid, chlorine and muriatic acid, and apparatus used therein

487. S. Henn and T. Haddon, Gibb-street-works, Birmingham—Improvements in the mode or modes of forming or making the heads of ornamental nails, when such heads are formed of a different metal or metals, from the shanks of the same

488. G. Coats, Glasgow—Improvements in partitions or "brattices" for coal mines and other under-ground works

489. F. R. Pfnor, Darmstadt, Duchy of Hesse-Darmstadt—Improvements in looms for weaving. (Communication)

491. J. Cowes, Swan-lane—Improvements in machines for washing and churning

493. F. Thompson, firm of Parker and Thompson, Sheffield—Improvement in skates

495. G. Parry, Ebbw Vale Iron Works, Monmouth—Improvement in puddling and refining of iron

497. G. T. Bousfield, Sussex-place, Loughboro'-road, Brixton—Improvements in power-looms. (Communication)

Dated February 27.

499. P. A. Lecomte de Fontainemoreau, Rue de l'Echiquier, Paris—A new cicatrising preparation. (Communication)

501. W. H. Jennings, Birmingham—An improvement or improvements in the manufacture of the guards and heel plates of guns, which improvement or improvements may also be applied to the manufacture of lasso rings and manillas

503. E. K. Allen, Strand—Improvements in the permanent way of railways

505. T. T. Jopling, Bishop's Wearmouth—Improved construction of water meter

Dated February 28.

507. W. Thompson, and C. Wilson, Birmingham—Improvement or improvements in buttons, and in attaching the same to articles of dress

509. I. Westhorp, London—Improvements in concentrating milk and in obtaining concentrated extracts from tea, coffee, and chocolate. (Communication from G. Borden, U. S.)

511. C. Frow, Wakefield, York—Improvements in furnaces for steam-boilers and other purposes

513. E. T. Archer, Cedar-cottage, Wandsworth—Improvements in envelopes for the transmission of letters or parcels

515. P. L. Grosrenaud, St. Etienne, France—Improvements in apparatus or furnaces for melting and puddling metals

Dated February 29.

517. J. Logan, Liverpool—Improvements in pumps, which improvements are especially applicable to bilge pumps on board ships and steam vessels

519. J. Markett, Hastings—Improvements in the manufacture of envelopes

521. J. Greenwood, Rawden, near Leeds—Improvements in heating water for the supply of steam-boilers

523. C. Barlow, Chancery-lane—Improvements in machinery for cutting cloth and other textile fabrics. (Communication)

Dated March 1.

525. W. Crozier, Sunderland—The better extinction of fire, street watering, and other purposes

527. R. F. Miller, Hammersmith—Improved omnibus

529. H. A. Dewar, Aberdeen—Improvements in conveying or transmitting motion for effecting mechanical operations

531. P. R. Hodge, Albion-grove, Islington—Improvements in the method of lighting domestic fires

533. A. Francis, Encomb-terrace, Wandsworth-road—Improvements in the manufacture of a composition applicable as a cement or plaster, and to other purposes

535. C. M. T. du Motay, Rue Fontaine St. George, Paris, and J. Fontaine, Rue Paradis-Poissonnière, Paris—Improvements in treating cast-iron

537. F. Rualem, Rue de Caris à Belleville, France—Improvement in the manufacture of fuel

Dated March 3.

539. A. Oppenheim, Manchester—Improvements in machinery or apparatus for stretching or distending velvets and other piled goods or fabrics, for the purpose of cutting the pile of such goods

541. J. Homan, Milk-street, Cheapside—Improved mode of driving sewing-machines

543. J. E. Hodges, Leicester—Improvements in machinery for the manufacture of looped and textile fabrics

545. J. E. Hodges, Leicester—Improvements in machinery for the manufacture of looped fabrics

Dated March 4.

547. L. Coddé, Rue de l'Echiquier, Paris—A system of submarine communication

549. A. Lambert, New Cut, Lambeth—Improvements in apparatus for regulating the drawing off of water and other fluids

550. C. T. Rosenberg, Clarence-terrace, Camberwell New-road—Improvements in ornamenting china, glass, and other surfaces, when transferring printed impressions

551. M. Samuelson, Scott-street, Hull—Improvements in screw-propellers

553. G. Lodge, sen., J. Ogden, and G. Lodge, jun., Leeds—Improved apparatus for effecting the consumption of smoke in steam-boilers and other furnaces

Dated March 5.

555. R. D. Kay, Accrington—Improvements in the manufacture of fabrics from fibrous materials

557. S. Last, Oxford-street—Improvements in trunks or portmanteaus, and an improved lock for the same

559. W. Green, York-street, City-road—Improvements in ornamenting and waterproofing fabrics

Dated March 7.

570. J. Downie, Glasgow—Improvements in moulding or shaping metals, and other materials

571. C. G. Häbner, Leghorn—Improvements in the treatment of ores. (Communication)

572. D. Brown and W. Brown, Smethwick—Improvement or improvements in rolling railway switches from railway bars, and in rolling taper ends or other bars requiring the same

573. F. H. Holmes, London—Improvements in machines known under the name of magneto electric machines

Dated March 8.

574. T. Cook, Addiscombe, Surrey—Improvements in portable bedsteads

575. H. B. Young, Barnstaple—Improvements in steam-engines

576. H. Cooke, Manchester—Improved machinery or apparatus for dyeing and dressing yarns or threads

577. J. J. Robert, Portugal-street, Lincoln's-inn-fields—A process which extracts the greasy particles contained in the waters after the cleansing of wools, by the means of sulphate of zinc and arsenicous acid

578. D. Y. Stewart, Glasgow—Improvements in moulding or shaping metals

Dated March 10.

579. R. Hannah, Glasgow—Improvements in pottery-kilns

580. L. Chablin and A. Hennique, Rue de l'Echiquier, Paris—A new mode of ornamenting ceramic and vitreous products

581. P. D. Nolet, Rue de la Lune, Paris—Improvements in penholders

582. P. H. G. Bérard, Paris—Improvements in manufacturing artificial flowers and foliage

583. R. S. Bartleet, Redditch, Worcester—Improvements in cases or holders for machine and other sewing needles

584. J. Mills, Oldham—Improvement in spindles used in certain machines for preparing, spinning, and doubling cotton and other fibrous substances

585. F. J. Emery, Cobridge, Stafford—Improved means of arresting the descent of cages or corves in the shafts of mines, which may also be applied to stopping the fall of weights

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586. J. Davy, Manningham, near Bradford, and J. Milnes, Clayton-West, near Huddersfield—Improvements in looms for weaving plaids, plain weaving and flounces or other ground-work

Dated March 11.

587. A. Tolhausen, Duke-street, Adelphi—Improvements applicable to bakers' ovens. (Communication from H. Berdan, Flatland, U. S.)
589. H. Greene, Windlesham, near Bagshot—Improvements in locomotive engines and carriages running on railways. (Communication)
590. O. Maggs, Bourton Foundry, Dorset—Improvements in the straw shaking apparatus of thrashing machines
591. H. Petitpierre, Avenue de St. Ouen Batignolles, near Paris—Improvements in sawing or cutting stone
592. J. Fowler, jun., Havering, near Romford—Improvement in the manufacture of bricks and tiles

Dated March 12.

593. H. Horner and R. Bagley, Sheffield—Improvements in buffers and draw and bearing springs for railway and other purposes
594. G. Spencer, Cannon-street—Improvements in supporting the rails of railways
595. J. M. Stanley, G. Bellamy, and W. Booth, Sheffield—Improvements in the manufacture of rolls for rolling steel, copper, lead, or other malleable material
596. C. R. N. Palmer, Strand—A new telegraph and improved telegraph or signal apparatus, parts of the invention, apparatus, or manufacture, being applicable to other purposes
597. J. Vigars, Marytavy, near Tavistock—Improvements in machinery for lifting in mines, also applicable to other purposes
598. E. A. Poutifex, Shoe-lane—Improvements in the manufacture of tartaric and citric acids and tartrate of potash and soda
599. L. M. Chalange, Nogent-sur-Seine, France—Improvements in corn-mills
600. W. Corbitt and G. Shaw, Masbro' Works, Rotherham—Improvements in buffer bearing and draw-springs for railway and other carriages
601. F. H. Edwards, Newcastle-upon-Tyne—Improvements in railway breaks
602. W. B. Hayes, Manchester—Improvements in looms for weaving
603. J. N. Ryder, Thames-street—An improvement in the slide-valve of steam-engines
604. G. Murray, Whitehill-point, Northumberland—An improvement in the construction and manufacture of wheels for locomotive engines, wagons, and other carriages, to be used on railways
605. T. W. Taylor, Cannelton, Perry, State of Indiana—An improvement in flying or roving frames

Dated March 13.

606. C. Duckworth and T. Marsden, Manchester—The manufacture of a new or improved woven fabric
607. P. H. G. Bérard, Paris—Improvements in the manufacture of waterproof fabrics, which improvements may also be applied for rendering other substances waterproof
608. J. Sturge, Kennington, and A. Sturge, Northfleet—Improvements in rotary fluid meters
609. G. Rees, Clerkenwell—An improved method of producing figured or ornamental surfaces on glass
610. I. Dixon, Liverpool—An improved propeller for steam ships and other vessels
611. G. de Chateauneuf, Rue de l'Echiquier, Paris—A hydro-pneumometric gas meter
612. T. Porter, Manchester—Improvements in looms for weaving carpets, coach-lace, velvets, and other piled fabrics. (Communication)
613. J. Murdoch, Staple-inn—An improved mode of manufacturing cut velvets and other similar fabrics. (Communication)

Dated March 14.

615. P. Pimont, Rouen, France—A certain process for restoring metallic spoiled pens
616. C. D. Gardissal, Bedford-street, Strand—An improvement in capstans. (Communication)
617. C. D. Gardissal, Bedford-street, Strand—An improvement in ships' windlasses. (Communication)
618. P. Marcus, Wells-street, Middlesex—An apparatus for working the damper in steam-engine furnaces. (Communication from J. Taylor, New Jersey)
619. W. Yates, Bromley—An improvement in furnaces
620. W. Clay, Liverpool—Improvements in the manufacture of the points or switches and crossings of railways
621. W. E. Newton, Chancery-lane—Improved machinery for separating gold and other metals from their ores. (Communication)

Dated March 15.

622. C. Coates, Sunnyside, near Rawtenstall, Lancaster—Improvements in apparatus for communicating motion to machinery used in bleaching, printing, dyeing, and finishing fabrics
623. L. J. Richard, Tirlemont, Belgium—Improvements in sugar manufacture
624. J. B. Hawkins, Reading—Improvements in couches or sofas, parts of which are applicable to other like furniture
625. E. T. Wright, Wolverhampton—An improvement or improvements in the manufacture of steam-engine boilers, iron ships and boats, and such other vessels and things as are or may be made by riveting together metal plates
626. R. W. Winfield, Birmingham, J. Sims, Fleet-street, and T. Lloyd, King's Norton, Worcester—Improvements in the construction and ornamentation of metallic bedsteads and other articles of metallic furniture
627. J. Rice and W. Rice, Foley-place—Improvements in breech-loading repeating guns and rifles
628. J. Dumas, Marseilles—An improved description of tile. (Communication, and recently patented in France, in the name of F. Arnaud)
629. W. Oldham, Southam, Warwick—Improvements in the manufacture of cement
630. H. Bessemer, Queen-street-place, New Cannon-street—Improvements in the manufacture of iron and steel
631. C. Randolph and J. Elder, Glasgow—Improvements in marine-engines
632. J. Pegg, Monkwearmouth—Improved steering apparatus

Dated March 17.

633. J. Mitchell, Dunnings-alley, Bishopsgate-street Without—Improvements in apparatus for washing and amalgamating ores and other matters
634. G. Hills, Belmont-hill, Lee, Kent—Improvements in treating fatty and oily substances so as to obtain stearine and oleine in separate states
635. C. B. Normand, Havre—Improvements in the treatment and employment of steam in steam-engines, and in apparatus for effecting the condensation of steam
636. J. Amos, Findsbury, Kent—An improved flour dressing machine
637. T. Palmer, Tavistock—Pumps with a new or improved box and valve
638. R. Thomson, Glasgow—Improvements in weaving
639. W. Graham, Glasgow—Improvements in marine compasses, and in adjusting the same on board ship

Dated March 18.

640. P. A. Lecomte de Fontainemoreau, Rue de l'Echiquier, Paris—Improvements in chains. (Communication)
641. P. de Prades, Camden New Town—Improvements in wheel-barrows
642. T. Bird and T. Rose, Manchester—Improvements in casters
643. E. Rowley, West Bromwich, Stafford, and J. Hadley, Birmingham—A new or improved method of shaping iron
644. E. Pettitt, Manchester—Improvements in machinery for preparing cotton and other fibrous substances
645. J. Drury, Paddock, near Huddersfield—Improvements in steam boilers for preventing explosion thereof
647. H. Barber, Belgrave, near Leicester—Improvements in the manufacture of hosiery goods
648. W. Smith, Salisbury-street, Adelphi—Improvements in the means of economising heat in locomotive engines. (Communication from A. Quanonne, Tournay, Belgium)
649. P. Appleton, London-street, New Swindon, Wilts—Improvements in knives for peeling apples, potatoes, and other fruits and roots

Dated March 19.

651. R. Morgan, Acton—A cellular purse
652. T. Richardson and G. W. Jaffreys, Hartlepool, Durham—Improvements in marine steam-engines
653. A. D. Lacy, Hall House, Knayton, near Thirsk, Yorkshire—Improvements in certain apparatus for taking up and delivering mail bags and other packages from a railway carriage or carriages whilst the train is in motion
654. B. S. Cohen, Magdalen-row, Great Prescot-terrace—An improvement in the manufacture of chimney-pieces, shop-fronts, pillars, pilasters, slabs, vases, and ornamental parts of buildings
655. J. D. M. Stirling, Black-grange, Clackmannanshire, North Britain—Improvements in steel and its manufacture
656. B. S. Cohen, Magdalen-row, Great Prescot-street—An improvement in the manufacture of penholders, handles, knobs, finger-plates, and umbrella and parasol furniture
657. E. S. Stott, Halifax—Improvements in the manufacture of mohair, alpaca, and worsted pile fabrics
658. D. Cope, Birmingham—A new or improved manufacture of spoons, forks, and ladles
659. A. V. Newton, Chancery-lane—Improved means for separating substances of different specific gravities. (Communication)
660. J. B. Hall, New York, U.S.—Improvements in preparing and treating pictures
661. C. F. Parsons, Lambeth—Machinery to be employed in the bleaching and dyeing of cloths, yarns, and fabrics
662. R. A. Brooman, Fleet-street—Improvements in balance slide valves. (Communication)

Dated March 20.

663. J. Leighton, Brewer-street, Golden-square—A luminous fireplace and self-supplying smoke-consumer
664. P. A. Lecomte de Fontainemoreau, South-street, Finsbury—Improvements in looms for weaving. (Communication)
665. J. Wadsworth, Hazelgrove, near Stockport—Improvements in the ventilation of mines, or in the means of removing noxious gases therefrom, and in machinery or apparatus to be used for that purpose
666. J. W. Burton, Eye, and G. Pye, Ipswich, Suffolk—Improvements in treating, flax, hemp, and other fibrous matters requiring like treatment
667. W. C. T. Schaeffer, Bradford—An improvement in treating soap-suds and wash-waters
668. J. D. M. Stirling, Black-grange, Clackmannanshire, North Britain—Improvements in mounting heavy ordnance for naval purposes. (Communication from M. Delvigne, Paris)
669. J. Trueman, Castle-street, Belfast—Improvements in ovens for baking
670. W. Drummond, Smith-street, King's-road, Chelsea—Improvements in spring hinges for swing doors

Dated March 22.

671. J. Murphy, Newport, Monmouth—Improvements in means or apparatus for stopping or retarding vehicles used on rail or other roads, which improvements are also applicable to the break wheels in connection with stationary engines
672. G. H. Brookes, Dalkeith, Edinburgh—Improvements in stoves, grates, or fire-places
673. W. Brierley and J. P. Brierley, Cleckheaton, York—Improvements in looms for weaving
674. W. Glover, Salford, near Manchester—Improvements in the construction and arrangement of machinery or apparatus for damping and beetling woven fabrics
675. H. Pratt, Worcester—Improvements in the construction of union mills, and in the application of the motive-power apparatus, and machinery connected with the manufacture of flour and bread, parts of which are also applicable for other useful purposes
676. J. S. Cockings, Ann-street, Birmingham—An improved envelope, and which said envelope he proposes designating as the despatch or return envelope
677. J. H. Johnson, Lincoln's-inn-fields—Improvements in weaving by electric power and in the machinery or apparatus employed therein. (Communication from M. L. B. Bauker, Turin, Sardinia)
678. J. Jones and A. C. Shirreff, Glasgow—Improvements in the construction and application of rotatory motive-power engines and pumps
679. J. H. Johnson, Lincoln's-inn-fields—Improvements in electro-magnetic printing telegraphs. (Communication from C. C. E. Minie, and L. F. C. Breguet, France
680. H. Brierly, Chorley, Lancaster—Improvements in self-acting mules for spinning and doubling
681. J. Hinks and G. Wells, Birmingham—Improvements in metallic pens and penholders
682. G. G. A. L. M. Schelhorn, Birmingham—A new or improved penholder
683. C. Carey, Union-grove, Wandsworth-road—Improvements in shower-baths
684. W. H. Barlow, Midland Railway, Derby—Improvements in covering and constructing bridges, viaducts, floors, and other structures of a like nature, when iron is used
685. C. Carey, Union-grove, Wandsworth-road—Improvements in the vessels and filters used for making infusions of coffee and other substances
686. J. Juckes, Dame-street, Islington—Improvements in furnace-bars
687. C. Carey, Union-grove, Wandsworth-road—Improvements in presses for copying letters and other documents, and for other uses
688. E. Barber, Tring, Hertfordshire—Improvements in mangles

Dated March 24.

690. T. Heaton, Blackburn—Improvements in self-acting doors and gateways
691. J. Bryant, jun., Plymouth—Improvements in machinery or apparatus for the re-burning of animal charcoal
692. J. Robertson, Ardrossan, Ayr—Improvements in transmitting motive power
693. P. Brown and G. Brown, Liverpool—Improvements in sizing and stiffening textile materials or fabrics by the application of new materials for those purposes
694. P. Brown and G. Brown, Liverpool—An improved ash-pan for fire-grates
695. R. Husband, Manchester—Improvements in the manufacture of hats
696. J. Tysoe, C. Tysoe, and P. Foxcroft, Salford, Lancaster—Improvements in machinery or apparatus for roving, spinning, and doubling cotton and other fibrous substances
697. W. Pitt and E. T. Davies, Birmingham—Improvements in the manufacture of brackets and castors for furniture
698. W. Clay, Liverpool—Improvements in the manufacture of wrought or bar iron
699. W. E. Newton, Chancery-lane—An improved coupling for connecting carriages, locomotives, and all vehicles used on railways. (Communication)
700. W. E. Newton, Chancery-lane—Improvements in cranes. (Communication)

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Dated March 25.

701. R. Caunce, Bolton-le-Moors, Lancaster—Improvements in the machines for spinning called mules
702. J. Bromley, Shelton, and W. Adams, Etruria, Stafford—Improvements in ovens used for firing porcelain and other kinds of earthenware
703. L. A. Gizard, Rue de l'Echiquier, Paris—Improvements in elastic mattresses and cushions
704. J. Aspinall, Limehouse—Improvements in apparatus for obtaining extracts and decoctions
705. W. Foster, Black Dike Mills, Bradford—Improvements in looms for weaving
706. J. H. Johnson, Lincoln's-inn-fields—Improvements in machinery or apparatus for raising nap or pile. (Communication from F. H. Schroer and C. E. Rost, Meissen, Saxony
707. J. D. Dunnicliffe, Nottingham, and S. Bates, Radford, Nottingham—Improvements in the manufacture of twist lace and weavings
708. G. H. Cottam and H. R. Cottam, Old St. Pancras-road—Improvements in the manufacture of chairs, bedsteads, and other articles to sit and recline on
709. J. Hargraves, Woollen Works, Carlisle—Improvements in the apparatus used for dyeing fabrics
710. G. H. Smith, North Perrott, near Crewkerne, Somerset—An improvement in the manufacture of saucepans, kettles, and other like culinary utensils
711. W. Ball, Chicopee, Hampden, Massachusetts—Improvements in machinery for stamping ores
712. R. Collins, Trent, Somerset—An improved agricultural implement
713. W. Illingworth, Manchester — Improvements in printing or colouring china, earthenware, or other ceramic manufactures, and in the machinery or apparatus connected therewith, and also improvements in the subsequent treatment of such manufactures
714. G. Wailes, Palace-row, New-road—Improvements in the means of actuating valves used for regulating the passage of gas or water in pipes

Dated March 26.

715. M. Weston and O. Carter, Rochdale—Improvements in machinery or apparatus for setting saws
716. J. Liley, Gutter-lane—An improved case or sliding-tube for candles, telescopes, opera-glasses, and is especially applicable to portable articles for the toilet, in travelling, and is called "Debas-cylindrical-etui." (Communication)
717. A. Tolhausen, Duke-street, Adelphi—A new process of producing chemical writing, and of marking and inscribing chemically any characters or figures upon paper or other substance of similar character. (Communication from H. Halvorson, Cambridge, Massachusetts, U.S.)
718. A. Tolhausen, Duke-street, Adelphi—An improved mode of manufacturing porous earthenware. (Communication from H. Halvorson, Cambridge, Massachusetts, U.S.)
719. W. A. Gilbee, South-street, Finsbury—Improvements in the manufacture of glass. (Communication from M. Salmon, Paris)
720. T. B. Daft, Irish Engineering Company, Seville Ironworks, Dublin—Improvements in the manufacture of metallic and other bedsteads and articles of metallic and other furniture
721. D. Lowe, Leicester—Improvements in knitting-machinery
722. G. Smith, Manor-road, St. Mary's, Newington—Improvements in envelopes for containing letters or documents
723. P. S. Rankin, Glasgow—Improvements in communicating or transmitting motive power
724. W. R. Barker, Chapel-street, and W. Toogood, Mount-street—Improvements in bottles, or in stoppering bottles, jars, and other receptacles
725. J. Rock, jun., Hastings—Improvements in carriages, parts of which are applicable to other structures
726. W. E. Newton, Chancery-lane—Improved apparatus for exploring under water. (Communication)
727. W. Clayton, Watling-street—An improved manufacture of soap
728. W. E. Newton, Chancery-lane—Improvements in macerating substances to be employed in the process of distillation. (Communication)

Dated March 27.

729. J. Taylor and J. Galloway, Bolton-le-Moors—Improvements in gauges for indicating pressure
730. A. Tolhausen, Duke-street, Adelphi—Improvements in watches and other time-keepers. (Communication from J. Muma, Hanover, U.S.)
731. J. Tall, Islington—Improvements in blind rollers, and in fixings for the same
732. W. Nicholls, Raunds, Northampton—An improvement in the manufacture of boots and shoes
733. R. D. Cumming, St. James's—A foot-stool and hassock combined. (Communication)
734. B. F. Brunel, Hampstead-road—Improvements in the manufacture of Prussian blue
735. J. Cliff, Burton-upon-Trent—Improvements in machinery for cleansing casks
736. W. Ball, Chicopee, Hampden, State of Massachusetts—Improvements in machines for separating copper and other metals from their ores
737. A. L. Hill, Birmingham—Improvements in furnaces for steam-boilers, japanners' stoves, and other such like purposes
738. E. Bufton, Piccadilly—An improved ink for marking linen and other fabrics, and in the case or holder for containing the same, and the implements to be used therewith
740. W. F. Thomas, St. Martin's-le-grand—Improvements in sewing-machines

Dated March 28.

741. J. A. Barratte, South-street, Finsbury—A new rotatory steam-engine
742. J. C. Meyer, Paris—Improvements in the construction of vices
743. W. Ward, Warrington—Improvements in apparatus for lubricating the spindles of certain machines, and in preparing and spinning
744. A. Daniel, Moorfields, Wolverhampton—Improvements in the manufacture of keys and locks
745. J. Webber, Torquay—Improvements in generating steam
746. J. Charitie, Cannon-street, and W. Smith, Salisbury-street, Adelphi—Improvements in the manufacture of small shot. (Communication)
747. J. Harrison, Geelong, Victoria—Producing cold by the evaporation of volatile liquids in vacuo, the condensation of their vapours by pressure, and the continued re-evaporation and re-condensation of the same materials
748. S. Getley, Ivy-street, Birkenhead—Improvements in supplying and drawing water to and from cisterns
749. J. Harrison, Geelong, Victoria—Distilling or evaporating in vacuo, condensing the vapour by pressure, and economising heat
750. A. Truemann, Swansea—Improvements in treating argentiferous regulus
751. A. V. Newton, Chancery-lane—An improved air engine for producing motive power by heated air. (Communication from J. Ericsson, New York)

Dated March 29.

752. A. Sands, Manchester—Improvements in securing rails in railway chairs, and in the construction of railway chairs
753. C. W. Williams, Liverpool—Improvements in the application of air propelling or exhausting apparatus for ventilating and like purposes on board steam-vessels
754. J. Swyney, Massachusetts, U.S.—Improvements in breech-loading magazine fire-arms
755. F. Puls, Soho-square—Improvements in galvanic batteries
756. J. J. Rippon, Oakenshaw Print Works, near Accrington—An improvement or improvements in rollers or cylinders for printing fabrics
757. R. Powell, Peter's-place, St. Martin's-lane—A new method of making up cotton, linen, silk, woollen, and other textile fabrics, whether waterproofed or not, into wearing apparel, horse clothing, tents, tilts, and all other articles or things for which such fabrics are used, by which method the article or thing when made up and worn is perfectly ventilated
758. J. Eives, Cornhill—A new mode of preparing fibres from plants. (Communication)
759. W. Muschamp, the Tyne Paper Mill Company, Gateshead—An improvement in manufacture of paper in order to render the same waterproof
760. H. N. Penrice, Newcastle-upon-Tyne—Improvements in machinery for driving galleries through rock and other strata
761. J. McLean, Glasgow—Improvements in treating or preparing textile fabrics and materials for increasing the density thereof
762. C. B. Normand, Havre—Improvements in steam boilers, in apparatus for applying heat to steam boilers, and economising heat of furnaces
763. W. Nimmo, Pendleton, Lancaster—Improvements in the manufacture of textile fabrics
764. C. D. Gardissal, Bedford-street, Strand—Improvements in steam boilers. (Communication)
765. A. Guido, Versailles, France—Improvements in cleansing, washing, scouring wool and woollen fabrics and yarns
766. C. D. Gardissal, Bedford-street, Strand—A new compound of inflammable materials for the purpose of lighting fires in grates, stoves, furnaces, or other fire-places. (Communication)
767. C. D. Gardissal, Bedford-street, Strand—An improvement in screw stop-valves. (Communication)

Dated March 31.

769. J. Hicks, Piddle Trenthide, Dorset—Improvements in stoves
770. B. Looker, jun., Kingston-upon-Thames—An improved mark or indicator to be let or fixed into the ground in burial-grounds and other places
771. C. J. Mélorel de la Haichois, Rue de l'Echiquier, Paris—Improvements in paving
772. H. Henderson, Glasgow—Improvements in stop-cocks or valves
773. C. Parker, Dundee—Improvements in machinery or apparatus for winding yarns or threads
775. T. W. Burrell, Fareham, Hants—Improvements in machinery for obtaining power by water. (Communication from Messrs. Mesnier and Cheneval, Pontoise, France)
776. H. Coruforth, Birmingham—A new or improved manufacture of plated tea-pots and coffee-pots, and other vessels and articles of like manufacture
777. A. Prince, Trafalgar-square—Improvements in steel-pens, for regulating the elasticity thereof. (Communication)
778. G. T. Smith, Northampton and J. Watts, Battersea—Improved lubricator
779. A. V. Newton, Chancery-lane—Improved machinery for folding paper. (Communication)

Dated April 1.

780. J. Bentley, Liverpool—Improvements in breech-loading fire-arms, and in the cartridges to be used therewith
781. C. Baptiste, Toulouse, France—Improvements in machines for manufacturing tenons and mortices. (Partly a communication of P. Maybon, Toulouse)
782. J. Ashton, Hyde Corn Mills, Hyde, Chester—Improvements in machinery or apparatus for bruising or breaking grain or other matters, preparatory to grinding
783. A. Southam, S. Stead, and J. Martin, Manchester—Separating or recovering the vegetable substances from mixed fabrics, and rendering the same vegetable substances again available for manufacturing purposes
784. A. L. A. Herbelot, Paris—A new method of obtaining a continual motive power
785. E. Laporte, Paris—The application of certain new material in the manufacture of bougies, candles, and other similar articles
786. J. Gray, Peckham—Improvements in steam-boilers, furnaces, and fire-bars
787. A. V. Newton, Chancery-lane—Improved apparatus for ascertaining gradients. (Communication)
788. W. Roberts, Millwall, Poplar—Improvements in the construction of pumps
789. J. Paterson, Linlithgow—Improvements in the manufacture of paper

Dated April 2.

790. F. Grice, West Bromwich, Stafford—New or improved machinery for the manufacture of bolts, rivets, spikes, screw blanks, and nuts
792. R. Roberts, Manchester—Improvements in omnibuses and other passenger carriages
793. P. M'Gregor, Falcon Works, Manchester, and T. Marquis, Huncoat, near Accrington—Improvements in the machines for spinning called throstles
794. J. S. Cottrill, Great Lever, near Bolton—Improvements in presses
795. C. Ellis, Stockport—Improvements in machinery or apparatus for spinning and doubling cotton and other fibrous substances
796. G. B. Galloway, Basinghall-street—Improvements in propelling vessels
797. L. Bonnard, Tottenham-court-road—Improvements in collapsible or folding hats and bonnets, and in flexible articles to be applied to other coverings for the head. (Communication from his father, J. B. Bonnard, Paris)
798. G. Gwynne, Trafalgar-square—Improvements in treating fatty, oily, and greasy bodies
799. H. G. Hine, Brecknock-street, Camden-town—Improvements in children's and invalids' carriages, called perambulators
800. H. Smith, Lee, Kent—Apparatus for cleaning and polishing boots and shoes
801. J. Samuel, Great George-street, Westminster, and J. Nicholson, Bow—Improvements in steam and other vapour engines
802. A. V. Newton, Chancery-lane—Improvements in the construction of rotary steam engines, applicable in part to pumps for raising and forcing fluids. (Communication from J. Broughton, Chicago, U. S.

PATENTS APPLIED FOR WITH COMPLETE SPECIFICATION.

614. W. Mc Carton, Clarence-place, Dublin—Improvements in the drying of corn or grain for grinding and preserving, and apparatus for performing the same, and is applicable to drying of other seeds—March 13
650. L. Ochs, St. Josse ten Noode—Improvements in the manufacture of certain kinds of paper from the refuse of tanned leather. (Communication)—March 19
739. C. J. Duméry, Paris—Improvements in smoke-preventing apparatus—March 27
862. P. Bancroft, Edmund-street, Liverpool, and S. White, Bond-street, Liverpool—A method of manufacturing certain oils or oily substances obtained from the petroleum, commonly called earth-oil, found in certain districts of the Birman Empire and elsewhere—April 10
868. L. Normandy, Judd-street, Brunswick-square—Improvements in the mode of writing and printing music to facilitate the study thereof. (Communication from l'Abbé Cormier)—April 11
900. G. T. Bousfield, Sussex-place, Loughborough-road, Brixton—Improvements in surface or fresh water condensers, chiefly applicable to steam-engines. (Communication from N. Thompson, jun., Williamsburgh, New York, U.S.)—April 15

ERRATUM.—In our notice of the Lille Cathedral Competition, *ante* page 147, *for* "Richard Poplarel," *read* "Richard P. Pullen;" and *for* "James Loudou Pealey" *read* "James Lyndon Pedley."

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MESSRS W.H.SMITH & SON'S PREMISES STRAND AND ARUNDEL STREET.

STRAND ELEVATION.

H. R. ABRAHAM, ARCHT.

SCALE OF 0 5 10 15 20 25 FEET

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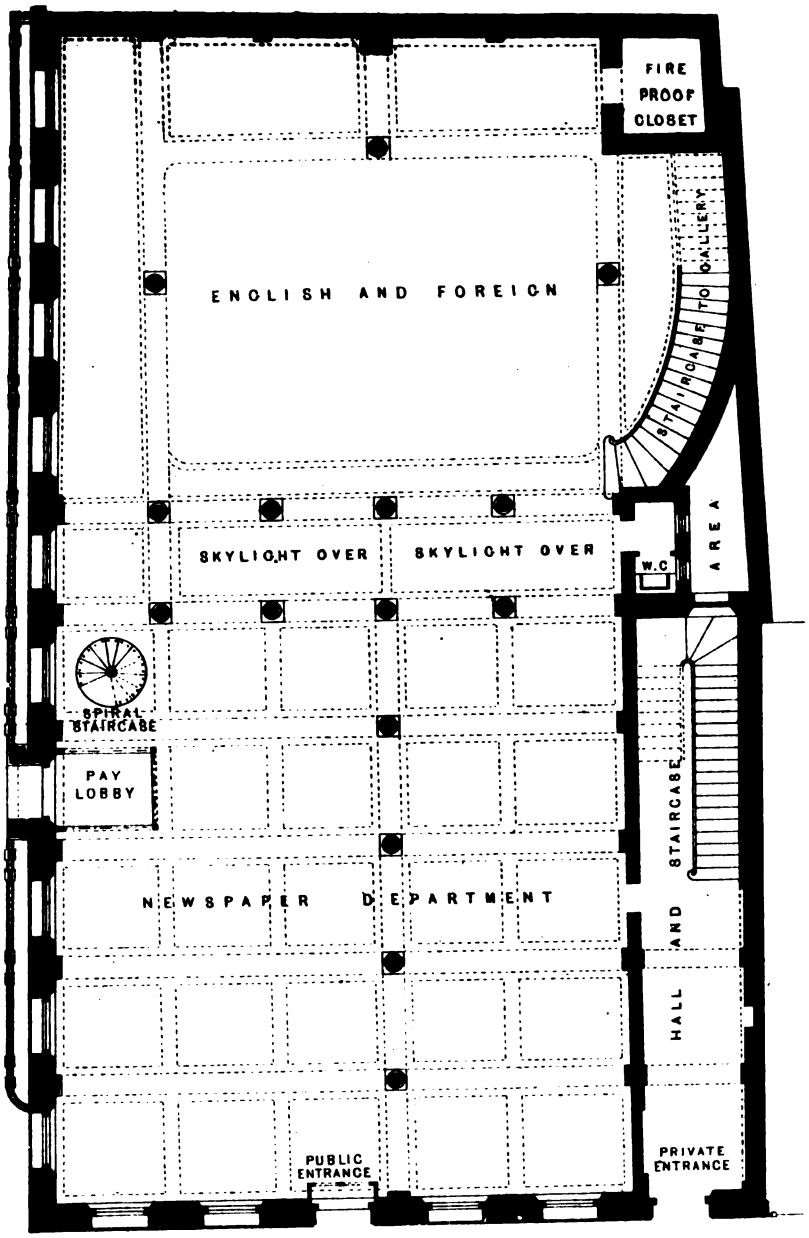
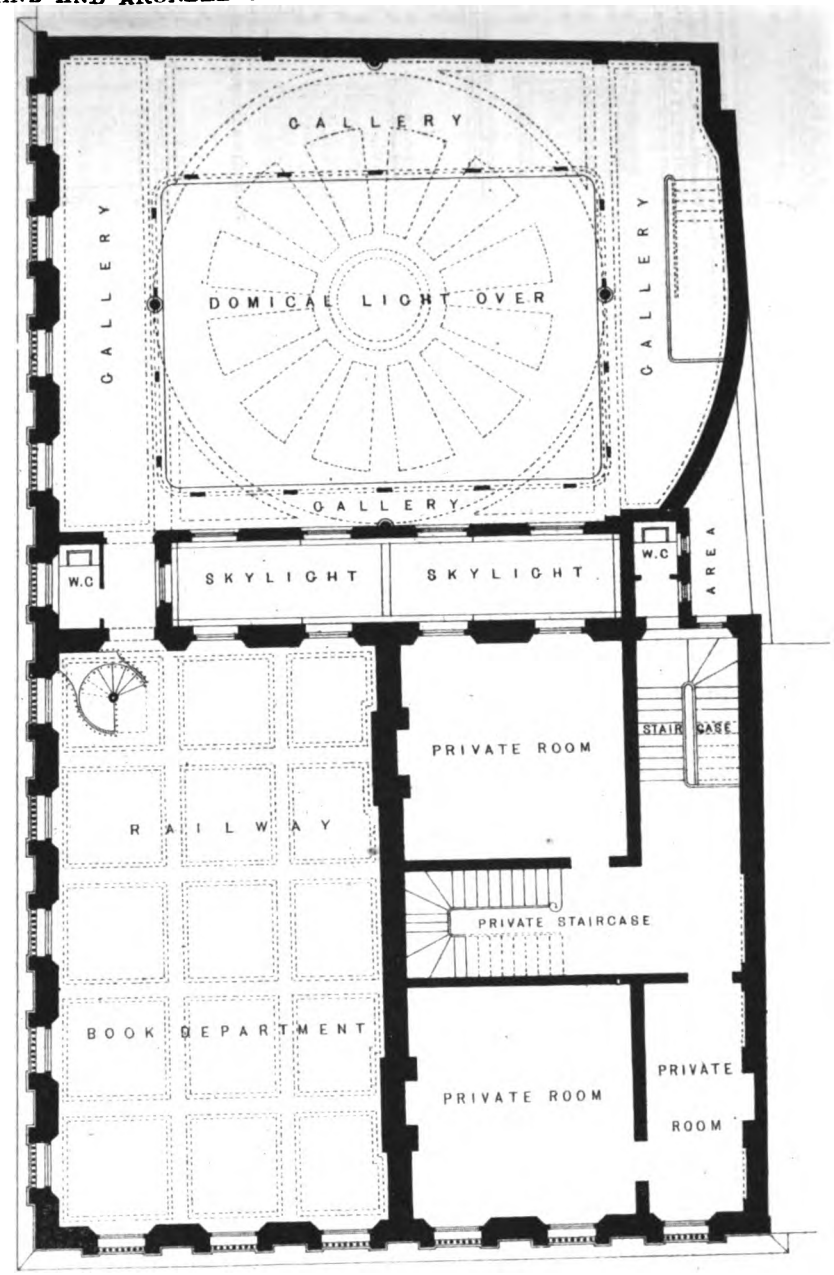
MESSRS W.H. SMITH & SON'S PREMISES, STRAND AND ARUNDEL STREET.

H.R. ABRAHAM. ARCHT



STRAND.
GROUND PLAN.



ONE PAIR PLAN.

SCALE OF 0 5 10 15 20 25 30 35 40 45 FEET

J.R.Jobbins

ARUNDEL STREET.

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MESSRS. SMITH & SON'S PREMISES, No. 182, STRAND.

H. R. ABRAHAM, *Architect.*

(*With Engravings, Plates* XV. *and* XVI.)

WE have already furnished a description of this striking pile of building, in the second of a series of papers entitled, "Architectural Improvements of London," at page 142 of the present volume of our *Journal*; to which we beg to refer our readers.

ARCHITECTURE AT THE ROYAL ACADEMY, AND THE WATER COLOUR SOCIETIES.

Royal Academy.

WHATEVER difference of opinion may exist among connoisseurs as to the general excellence or the contrary of this exhibition, (and we are among those who side with the former), there cannot be a question that in the architectural department, it is poorer both in interest and quality of drawings than it has been for some years past. Whether the profession be disposed to retaliate on the Academy for long-continued apathy, and are reserving their works for their own Architectural Exhibition, it is impossible to say, but certain it is that as the latter has during the last few seasons been growing into esteem, the Academy would appear in a like ratio to have fallen off. Now, although the Architectural Exhibition has had from the first our warmest sympathy, (and it is a reproach that in its earlier stages it should have lacked support from the press as well as from the public), it by no means follows that the older, and in many respects most valuable, institution should become neglected,—and for more reasons than one. It is a chartered establishment, under direct royal patronage, which of itself brings in train the countenance of the fashionable and influential world. The cultivation of taste in architecture forms one of the three great objects for which that establishment was founded; it is thus recognised in the appointment of a Professor, as well as by its share in the occupation of the Library, and, till a comparatively recent period, there was a room exclusively devoted to the exhibition of its works of art. These advantages it is manifestly desirable to maintain, and we therefore urge the profession not to render them nugatory or virtually cancelled by any apparent want of appreciation on their part. There is enough room both for the Academy and the Architectural Exhibition, and each has its peculiar sphere of usefulness; each may pursue its course, not impeding the other, but conducing to one common end.

As we have hinted, the architectural drawings this year are for the most part not in themselves especially interesting; none of the Academicians are exhibitors, but acceptable contributions from both the Associates grace the walls. In point of numbers, there appears to be a larger total than sometimes, and they occupy more space in that little "North Room" of which erst they held undisturbed possession. Generally speaking, the pictures are tolerably well hung, but some glaring absurdities are evident. What, for instance, can be more nonsensical than placing delicate or outline drawings such as (1069) nearer to the ceiling than the floor? or some others, intrinsically deserving of study, where it is a chance if they are observed at all? Such, for instance, as Mr. Slater's "Iron Church" (1071)? There are more important duties for the hanging-committee than the close packing of picture-frames.

Architectural models are this year entirely wanting. This is a pity, for though it is a branch of art not very much patronised, yet it is not without its use, and is sometimes the only medium of properly conveying the relative expressions of buildings.

The first architectural drawing in the catalogue is (1053) "The German Lutheran Church, Camberwell" (G. Low), a little simple Gothic building, without turret or anything to take off its barn-like outline. True, there is a small projection at one end, in shape a half octagon, but of such timid size as scarcely to assist the outline. There is also an *attempt* at gabling in its windows. In the centre of the side is the entrance doorway, large, and in a pseudo-porch formed between two buttresses. (1054) "Church proposed to be erected in West Canada," T. C. Sorby, is somewhat better, but errs in the other direction, being strainedly picturesque. Here, again, are windows gabled dormer-fashion. Messrs. Bidlake and Lovatt's designs are always marked by a degree of taste, and have the advantage of being cleverly delineated without transgressing architectural propriety. There is only one drawing exhibited by them this year, which falls rather short of their usual standard, and for this reason, that for the sake of a certain frontal effect the true dictates of the plan have been sacrificed. The design is for a "Baptist Chapel at Brompton, Middlesex" (1055), really under one roof; but apparently under the old disguise of three. Apart from this drawback there is much in the bold massing and unbroken line of frontage that is commendable, always excepting the fussy labels over every opening, and a smattering of the "domestic"-looking here and there. Mr. Blore's "Designs for erections on a Suburban Estate" (1056), would have been more in favour a few years back. The same gentleman has also a little view (1113) of the "Tower and part of Worcester Cathedral," faintly depicted.

The delightful bits of Moorish architecture with which Mr. Macquoid favours us from time to time—so charmingly drawn, too—interchange pleasantly with Northern Gothic and Italian: (1057) "Cloisters at Valladolid," by him, is a powerfully treated subject, highly interesting. Of Italian mediæval structures we observe several drawings, some by Mr. Aitchison, as (1058) the "Tombs at Verona," so much eulogised by Mr. Ruskin, an excellent drawing, though showing little beyond the general effect; and (1125) a "View in Rome" of three arches, which do not appear to us to have any special beauty. Other pictures of this class are exhibited by—F. Oliver (1091) "Tesselated Pavement in St. Mark's, Venice," a painfully-mechanical drawing,—A. W. Blomfield (1093) "Church of the Annunziata, Genoa,"—J. D. Wyatt (1117), two pen-and-ink sketches from "Nuremberg,"—G. P. Boyce (1149), "Part of St. Mark's, Venice," of the "baptistery" to which Mr. M. D. Wyatt contributes (1141) a telling interior in glooming grandeur,—F. P. Cockerell, and W. W. Deane, other gleanings from Rome and Venice, &c.

The subject of the "Birmingham and Midland Institute" is revived, in the shape of two important drawings; one ("for which the first premium was awarded") by Mr. H. R. Yeoville (1059), and the other as "about to be erected" by Mr. E. M. Barry (1142). We are not prepared to say how it comes to pass that the design which was thought eligible for the first premium has not been adopted, but, as far as *architectural* merit is concerned, the second is undoubtedly the better conception. We had occasion to refer at length to this design when examining the geometrical drawings as sent in by Mr. Barry to the last Architectural Exhibition. In the present instance he sends a large perspective (rather heavily coloured, by the way), also two plans showing very comprehensively their excellent arrangement, and two effective interior sketches, viz. the museum, which is lighted from above, and the theatre, a quadrant form on plan, having a coved ceiling, and sculpture judiciously introduced here and there. Mr. Yeoville's drawing is simply an exterior view, feebly depicted, and with many faults in the design. The principal entrance is central, and marked by a series of projecting coupled columns (Doric), whose position, as usual, regulates the triglyphs, which thus fall irregularly and awkwardly in the frieze. The lower story consists, chiefly, of a series of arches with windows in the spaces, and is rusticated in the spandrils above the imposts only. The line of the attic is slightly broken by the centre and wings being raised higher than the rest, and by the pyramidal vases (?) which occur at the usual intervals. Sculpture is very sparingly employed. We may here repeat our regret that, owing to some difficulty or other always arising, there seems but slight hope of the public generally obtaining a fair comparative view of competition designs. One and another of their authors slips his production into an exhibition, where the probability is that it will be lost among rival attractions, and there the matter drops till the next chance, when perhaps a couple or so more forward theirs "on view;" after this the matter may be expected to drop altogether, unless it be started afresh by some other luckless individual, loth to blush unseen.

Nos. (1060) and (1154) form part of the one subject—the "Courts erected at the Crystal Palace," from Mr. Digby Wyatt's designs. These two drawings are by far the most superb in the room, the latter in particular, which is some 18 feet in length, and illustrates the succession of "courts" on the south side, including the Byzantine, German Gothic Vestibule, Mediæval, Italian Vestibule, Renaissance, Elizabethan Vestibule, Italian, and a second Italian Vestibule. The amount of labour bestowed on these drawings is inconceivable, and the care which ensures their correctness renders them doubly valuable. (1061) Mr. H. R. Newton's "Suggestion for a Roadway across St. James's Park," is at the Duke of York's column, not through the Enclosure. The

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author retains this column, but flutes it, adding memorial or military devices; a roadway being contrived below on either side by an incline sufficient to gain headway under the present pavement; the design is completed by the addition of lodges, equestrian figures, &c. Architecturally speaking, the details are out of proportion, but as a scheme it is entitled to praise as one medium for obtaining a very desirable boon. We regret not being able to commend the "Neild Memorial Window, and Restorations at North Marston Church," exhibited by Mr. Digby Wyatt (1062) Independently of the period of Gothic style adopted, its features are not made the best use of: it may be that the designer, in taking unusual pains to honour the occasion, has, as is sometimes the case, produced an inadequate result. Mr. Daukes contributes but one picture (1063), "Schools erected at West Bromwich." There is no attempt at display in any part of the building, nor even picturesqueness of plan; in fact, there is an air of tameness and uniformity. The most striking arrangement is that of gabling a separate roof to each of the windows, a practice which we have before referred to as seemingly now coming very much into vogue, and of which there are many examples in this very exhibition. (1064) "The Drawing-Room at Baddesley Clinton, Warwickshire" (A. E. Everett), is hung too high to show it properly. There does not, however, appear to be anything in it beyond that of having a large window and handsome fireplace, the almost unvarying concomitants in old Elizabethan mansions. Mr. Lote's "District Church at Bugaildy, Radnorshire" (1065), is very commonplace. What we wish to see is less of this stereotyped conventionality, and more of that genuine feeling which, discerning and appreciating fundamental beauties, yet knows how to diverge from the beaten track without offending sound principles or good taste. We have already referred to the position of (1069), as precluding all examination, beyond observing that the rood-beam extends across what appears to be a very wide church, and somehow looks flimsy and attenuated. Both here and in Mr. Nichol's "Altar," &c., in a Roman Catholic chapel at Liverpool (1119), there is a lavish display of ornament, in this latter case exceedingly well applied. Let us pass an approving word, too, as to the masterly style of delineation. Another artistic sketch, though slight, is of the "Salt Tower, Tower of London" (1066) (J. Bonser), now disclosed by the removal of adjoining buildings.

We marked for special examination No. 1071 in the catalogue, —"Design for a Church to be constructed of Iron, prepared at the instance of and for the Ecclesiological Society," by Mr. Slater, —and are greatly disappointed to find it hung so much above the eye, that very little can be made out; but the architect seems to have needlessly adhered to the cut-and-dried stone type; whereas, in the use of a material which has so little in sympathy with others, one, moreover, in which so much excellent novelty may be devised by the "cunning workman," one naturally looks for some development of its capabilities—some decided recognition of its presence. Iron is, undoubtedly, *the* material of the day, and while our engineers are practically demonstrating their sense of its utility, let not architects neglect their tribute to its powers, but seek to clothe the stubborn framework—the bare skeleton—in its most attractive garb. There is a notable example of this application of iron in (1115), by an eminently practical master of our art, Mr. Sydney Smirke, in the "New Reading-Room at the British Museum," exhibited in two sections, one showing its construction, and the other its finished state. This mention will be doubtless sufficient to the majority of our readers, as several views of it have appeared in the public prints: it may be enough to add that it is to be circular on plan, and roofed in one span by semicircular ribs. It will be fireproof, constructed wholly of brickwork and iron, lighted by a range of windows all round which pierce into the dome, thus causing an agreeable play of outline at a juncture where it is of most value; and the effect is further enhanced by colossal statues which are ranged on projecting trusses at the foot of the ribs of the ceiling. There are two of the "Designs submitted for the intended Grammar School at Rotherham," one by Mr. Blackburne (1072), and the other by Messrs. Clarke and Worthington (1074). Both are very fair, but we prefer the latter, as looking more characteristic, and as presenting an agreeable play of light and shade, and massing of materials. The "Old House at Ightham" (1073), by Mr. Deane, is a capital sketch, no doubt a faithful one; as also is Mr. Dollmann's "View of the Inner Court, Grey-friars' Hospital, Coventry" (1106), an exterior view of which, equally correct, is shown by Mr. J. D. Wyatt in (1167).

One of the most showy pictures is (1075) "Proposed Interior of the new Building of Messrs. Sarl and Sons, Cornhill," by Messrs. Barnett and Birch. It is apparently a spacious room divided by a gallery all round into two heights, and lighted chiefly from above. With sundry exceptions in points of detail, such as the mode of starting the consoles under the ceiling, and occasionally a seeming coarseness of decoration, this is a show-room befitting any of the "merchant-princes" of London. The large picture hung next to it (1076), is one of considerable merit both as to architectural and artistic treatment; it exhibits the "Interior of Bedminster Church," lately erected by Mr. Norton. The style is, of course, Gothic, rather early in character, and purely treated; the accessories appear complete and well designed—(the reredos was exhibited in a photograph at the Architectural Exhibition)—and the font, the bowl of which is encircled by angels, is both novel and successful. The "Design for the completion of the Parish Church, Leamington" (1088), A. Johnson, purposes to raise on the straggling and somewhat weak piers of the cross-intersection, a huge square tower in two stages, each having two traceried windows on the face, and finished with a parapet and pinnacles,—the whole composition being very similar to that of Hedon, and some other Yorkshire towers,—and, by its size, reducing the present extra-lofty church to one of ordinary appearance. The interior view (1151) contemplates but little alteration; more value is here given to the details than they can actually boast, they being in reality both slender and poor. While speaking of churches, we must call especial attention to (1114) Messrs. Barnett and Birch's "Design for St. Luke's Church, New-road," as particularly distinguishable, not by evidences of pure taste or skilful treatment, but as being of the worst possible character, without a single redeeming feature. Mr. Penson's "New Church, Wrexham" (1123), and Mr. E. C. Robins' "Design proposed to be erected near London" (1143), must fall likewise under censure, as sadly wanting in the true spirit of Gothic architecture. A glance at these, in comparison with a few of the well designed churches, will explain more than pages of dry criticism. Look, for instance, as a simple model, at Mr. E. M. Barry's "Haverstock-hill Church" (1080), or, for a more elaborate one, at (1107) "New Church about to be erected at Halifax," by Mr. G. G. Scott, whose talents we are glad to observe have been recognised in the Academy, by their electing him an Associate. The noble tower and spire in this latter drawing display consummate skill in design and arrangement. The "Church erecting at Wells" (1096) (architect's name not mentioned) is but of average merit. There are gables roofed to the side windows, and a wiry-looking steeple does not improve the grouping. The walls throughout are banded in light and dark stone, which cuts up the features miserably, and destroys repose. (1164) "St. Peter's Church and Stanley Gardens, Notting-hill" (T. Allom), and (1176) "Parish Church and Schools at Hakin, Milford Haven" (Lindsey and Flower), are again faulty. "St. Mary's, Martham, Norfolk," a restoration (interior view), by Mr. Boyce, is so far good that it preserves all the localisms of the county; the drawing is not a pleasant looking one, partly from the awkward point of sight selected, and partly from the general proportions of the building, and from the anxiety of the draughtsman to make the most of the nave and its beautiful roof, extending it beyond the natural range of vision.

There are views of several large mansions, completed or in progress, among which perhaps the most prominent is that erecting for Baron James de Rothschild at Ferrieres, France, by Sir Joseph Paxton, who exhibits two drawings (1155 and 1165). It looks as if constructed on a similar plan to his Mentmore, the new mansion visible beyond Cheddington on the North-Western line, now building for another of the Rothschild family. In this latter case, as we have before had occasion to remark, the author borrowed the design largely from the fine old hall at Wollaton, one of the noblest examples of its class in the kingdom; while in the present one, though in the main a similar outline is adopted, for want of those wild eccentricities which characterise the Elizabethan of the former, the composition sinks into a ponderous mass, one in nowise grand except in size. Roofs and chimneys are totally ignored. Mr. C. Barry, jun., in his "Bylaugh Hall" (1175) has followed the same period of architecture (the pilastered and banded Elizabethan), but with much greater success. Indeed, however we may be disposed to object to this species of detail as not altogether the purest art, yet as a variety it may be here and there tolerated, and, when well managed, may be even acceptable. What a contrast to this is the picture below!—(1177)

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"Design for alterations at Brankaea Castle, Dorset," by Mr. P. Brannen. Here we see a confused jumble of round towers, slits of windows, and all the paraphernalia of ancient castles—to a diminished scale!—Hence that very effect of solid stability and solemn state which those time-honoured structures invariably display, is in such modern puny imitations wholly wanting. As far as manipulation goes, this drawing is deserving of mention, though rather overlabounch. A better specimen of the "revived castellated" is "Dynevor Castle" (1089), now being altered by Mr. Penson; if we except the windows, which are again decidedly inconsistent with the feeling of the style. It is very difficult, we know, to engraft modern improvements on ancient proprieties, without interfering with, and perhaps destroying, their individuality of expression. But it is in these applications that genius reveals itself; still, where the difficulties are irreconcileable, there can be no question which should give way.

"Rock Retreat, Charnwood Forest" (1179), C. G. Wray, and "Design for Country Buildings" (1174), J. Norton, may be quoted as specimens of Gothic well and consistently treated for domestic purposes; and, for buildings of a more public class, we may remark Mr. Moffatt's "Taunton Assize Courts" (1134), as pretty and picturesque a bit of grouping as any we see. Still, we should not recognise its purpose externally, especially as here shown in the midst of a luxuriant plantation; but we have reason to understand that the arrangements of the plan are thoroughly studied and suitable. (1090) "Wemyss Bay House, near Greenock," designed by R. W. Billings, is a thoroughly Scotch residence, revelling in curious corbellings and mysterious little rooms,—perhaps rather overdone in this respect. "Exeter College, Oxford, showing the contemplated new chapel, library, rector's residence, &c." (1094), is a good bird's-eye view, in which tinting is made (as it should be) subservient to the architecture. The principal building is the chapel, lofty, in one span, and apsidal at the east end; it has a small turret. The library may be noticed as of unusual design, a parallelogram on plan, in two stories; the upper one, being chiefly plain walling, is relieved by a continuous shafted arcade, with narrow windows occasionally between: handsome spherical dormer windows above make up an effective exterior. Mr. Scott may be congratulated on the worthy addition he is thus making to the *material* attractions of Oxford. (1136) "Two Views of Addington Park, Buckinghamshire," now being erected by Mr. P. C. Hardwick, are deserving of remark as among the best adaptations of continental ideas to English domestic work; far better than Mr. C. B. Allen's "Street Architecture—hint from Verona" (1132). Mr. Talbot Bury's "New Market-house, Weymouth" (1133), is disappointing. The style is Italian, and plain,—but with this we should not find fault; it is the heavy attic which spoils the effect, especially in the centre portion, which is sadly overladen. The "New Music Hall, Covent Garden," by Mr. W. F. Hill (1146), is really a good design, with much that is truthful in the materials and enrichments. Mr. E. Falkener's "Pompeian Studies" (1121 and 1122), are a continuation of the series he has been for some time preparing, and are specimens of careful and minute drawing as well as characteristic colouring. The style of decoration in the former drawing (of a *Solarium*) is Etruscan, which was occasionally made use of by the Pompeians in the same manner as Gothic architecture is restored by us in the present day. The "Restoration of the lost Group of the Eastern Pediment of the Parthenon" (1082), by the same gentleman, is placed above the line, and consequently its minutiæ cannot be detected. The subject illustrated is the birth of Minerva; the composition appears natural, and the sculpture is relieved by the blue background of the tympanum; colour is indicated also on the other architectural details of the entablature and columns. (1083) "Design for the Town-hall, Rugby" (C. L. Eastlake), is in red brick, rather whimsically treated; the grouping is heavy, and not well managed: some foreign types appear to have influenced the character of the design. This is the only drawing exhibited out of the many forwarded to the above competition. (1087) Mr. Clayton's "First design for the Hereford Central Station" is a simple Italian composition, very nicely balanced as to form and masses. Messrs. Banks and Barry's "New Hall," for Ludgate-hill (1092), is not so good as many of their works; at any rate judging by this drawing. The colours in the ceiling, in particular, seem injudiciously chosen. (1095) "Design for New Schools, Oswald Kirk, Yorkshire," by N. T. Randall, is very poor and wanting in proper feeling. Another design for some schools at Pwllheli (1102), by Messrs. Wehnert and Ashdown, is much better. The "Hotel proposed to have been erected in Brook-street, Hanover-square" (1101), by Morgan and Phipson, is good, if we could but recognise the principle of piling order on order, as in some parts of this elevation. (1118) Mr. Penrose's "New Market-house at Castle Cary" is affectedly quaint, and has many incongruous features. In (1147) "Design for a Sepulchral Monument, in the style of the 13th century, with an adaptation of modern costume," Mr. Pullan has shown considerable skill, especially in the figure. The altar tomb itself appears needlessly plain, while the arch above it, with its profuseness of sculpture, is inconsistently rich. Coloured decoration is introduced. (1148) Messrs. Mosley's "City Bank, Finch-lane," beyond a rather prettily contrived entrance (like many others in the neighbourhood, placed in a canted corner of the building), has nothing to call for remark. (1150) "Little Dalby Hall, Leicestershire," as being altered by Mr. Bell, shows originality and skill in the interior enrichments. A "Design for a Congregational Chapel" (1152), by H. J. Paull, is mainly noticeable for its peculiar arrangement of roof-timbering, reminding one of the large warehouses of the continent, or some of our own mediæval barns. The plan is essentially an *auditorium*, the pulpit being situate almost directly in the centre of the area, which may, in block form at least, be said to follow the outline of a nave, aisles, transepts, and chancel, the extreme part of the latter being screened off into two vestries.

Several designs for the "Sheffield School of Art" appeared in the Architectural Exhibition, and Messrs. Manning and Mew now send an elevation (1157), "as being erected." On the drawing the colours of the materials look very glaring, as the banding which is interspersed with the red brick, of which the substance of the walling is constructed, serves only by its contrast to heighten the effect. Time, in this as well as other things, will do its work of subduing and toning down. (1163) "A Country Residence," H. E. Kendall, is miserably frittered. The "Inlet Tower for the Waterworks, now in course of construction by the Government of India, for the supply of Bombay" (1173), is an interesting but not showy drawing. The leading outline is not quite to our mind, but the octagonal lantern and balcony at its summit is described as "an example of the applicability of the Indian variety of pointed architecture to structures of cast-iron." The height of tower is 104 feet, of which 50 will be beneath the surface. With this we close our present notice, and shall look forward with some anxiety to next year's display. Let neither the claims of the Architectural Exhibition nor of the Academy be overlooked.

The Society of Painters in Water Colours.

This collection, as a whole, is perhaps the best that has been seen for years, and it has the advantage of not being too large; one can feast the eye and improve the taste without perplexity or weariness. Architecturally speaking, there is not much to notice. Mr. W. Callow blends his artistic skill most delightfully with the severe forms of brick and stone, and exhibits several specimens, as (44) "Old Houses on the Rhone;" "The Close Gate, and Widows' College, Salisbury" (69), a perfect study of effect and detail; "The Hotel de Ville, Brussels" (46), of which a portion of one side only is shown, and in shade (omitting its characteristic tower); but the old dwellings in the market-place, and the scene around, compose an admirable picture. In (84) "Werner's Chapel, Bacharach," the glow of the sunshine on the different surfaces is excellently given; the tracery in the ruined windows, like the rest of the detail, is carefully made out. (86) is another picturesque subject, "The Bear and Billet Inn, Chester," one of those curious overhanging wooden erections of the olden times, which few places besides Chester, Shrewsbury, and Tewkesbury, can now show. The famous "Rialto at Venice" is the subject of another picture (95), embracing also some of the surrounding buildings. "The Market Strasse and Rath-haus, Hanover" (123) is a strange-looking pile, of red brick chiefly, and confused in design,—certainly not to be taken as a model. "Rue de St. Pierre, Caen" (148), shows the celebrated steeple, a grand study of simplicity; and (221) "Ancien Pords de la Ville, Bruges," is a little gem. (248 and 294) are from Venice, and more picturesque than architectural. The "Remains of the Roman Theatre at Arles" (17) by J. Burgess, jun., are interesting, though so little appears to be left; what is here shown is merely some well proportioned columns, coupled. A kindred scene is depicted by Mr. Glennie in (165), "View in the Forum at Rome," in which the chief objects are of course the columns of

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the Jupiter Stator; in the distance is seen the arch of Constantine, &c. Mr. Burgess's "Porch of Chartres Cathedral" (25), is cleverly made out. The point of view is not very happy, being too foreshortened to do justice to the amount of sculpture in the doorways. (67) "Porta Nigra, at Treves," by the same artist, is also well shown. It forms a curious study for the architect. Also his "Part of the Pope's Palace, and the Pope's Mint, Avignon" (107), the "Chateau at Dieppe" (108), and the "Cathedral at Dijon" (156), must be mentioned with commendation. Of Mr. Holland's pictures, the best is (89) "Market-day in Genoa," in which the buildings are picturesque and make up a pretty group.

Mr. J. Nash is a liberal contributor; all his productions, we believe, consist of views in Oxford, chiefly interiors of colleges, such as (28) "The Hall at Queen's;" "All Souls' Library" (108); "The Hall of Magdalen" (239; "The Bodleian Library" (261); also (20) and (123) "Christ Church Cathedral," (135) "Merton College Chapel;" and (201) "Porch of St. Mary's Church," a most unfortunate Jacobean design. As truthful delineations, these are wondrously successful; but beyond this not much can be said, the parts are all so tiny and the colouring so raw. Lastly, we may draw attention to Mr. Gastineau's "Melrose" (201), taken from a favourite point; and Mr. Brandling's "Street in Nuremberg" (186), as displaying some excellent and ingenious half-timbered framing in several of the dwelling-houses.

The New Society of Painters in Water Colours.

In this collection, which is a numerous one, there are various objects bearing upon our art, and which deserve mention. Mr. Chase is by far the largest contributor in point of numbers, and his productions may be generally detected by a certain hardness of outline which is not atoned for by any peculiar attention to detail. Haddon Hall, as of yore is a favourite spot, and has furnished Mr. Chase with several subjects. The first in the catalogue is doubtless from thence also, though not so designated; it is a very nice sketch of the well-known terrace and flight of steps, of which sundry other peeps are discernible in other pictures. But of all the views of Haddon, commend us to that of the "Hall and Bridge" (136) by Mr. McKewan, a perfect gem. Among Mr. Chase's other works may be mentioned—"Ham House, the garden entrance" (120), more interesting from its historical associations than from anything here shown. We see merely a sprawling iron gate, poorly designed in comparison with many of the kind, and connected with two stone piers equally unmeaning and unsatisfactory. While so many excellent relics of old ironwork abound, so delightfully fantastic and attractive, too, to the pencil, we should certainly have put "Ham House" aside for the present. (122) "Tintern Abbey" partakes of the fault we have mentioned, hardness of outline; it is moreover badly drawn. "Newstead Abbey" (156) is rather better; (176), "Porch of the Priory at Hampstead," better still, and very cleverly coloured; but (300), described as "In Henry VII.'s Chapel," we cannot at all identify,—it is also wretchedly drawn. The "View of Melrose Abbey" (2), by Mr. Hardwick, is very careful and correct; but from the point which the artist has selected, the parts appear rather huddled together, and the tower (unless become a more decided ruin of late) does not look to rear itself sufficiently. The venerable pile is shown in all its desolation, with but a tombstone here and there around. In another part of the exhibition is a view of "Netley Abbey" (133), by Mr. G. S. Shepherd, with one of those pic-nic parties for which this ruin is so unseemly a resort. Venice, as usual, is a fertile theme;—"The entrance to the Grand Canal" (3) by Mr. Wyld, is a gorgeous picture—a blaze of (Claude-ian) sunshine,

"Dim with excessive light,"

revealing the domes and porticoes in obscure masses only. (18) "Old St. Pancras, twelve years ago" (J. Chase), represents the quaint old church surrounded by trees and village scenery, such as in our time we do not remember. Nor as a reminiscence of the building is it very faithful, as those who recollect the curious outline of the cupolic roof to the tower will detect. (45) "Seal, near Sevenoaks," by the same artist, is better handled and more boldly drawn. (174) "Tintern Abbey" is the largest and by far the best of Mr. Chase's works. The "Cottage in which Bewick was born" (19), J. W. Archer, is worth noticing, partly for the subject, and partly to remark how unpleasantly it is treated as a composition, the unbroken horizontal lines being carried on by the massing of the adjoining rick, whereas a few footsteps either to right or left would have obviated this tameness and sameness. Two contributions by Mr. Whymper will merit close inspection: (43) "Old Eastbourne," and (117) "Entrance Tower, Hurstmonceaux Castle, Sussex;" the latter, in particular, is scarcely surpassed by any of its compeers in vigour or breadth of colour, with scrupulous adherence to precise form. It will be needless to direct attention to Mr. L. Haghe's two magnificent pictures, (59) "Antechamber in the Ducal Palace, Venice," and (64) "Town Hall, Oudenarde." Each is a perfect study, and a marvel in depth and power of effect. The architectural accessories are doubtless true and carefully rendered, the style in the former appears to be Italo-Elizabethan of very inferior kind; that in the latter a superior description of the "ogival" or flamboyant of the continent. The ingenious and intricate combinations which abound will not pass unregarded. We are surprised that so clever an artist as Mr. T. S. Boys should have been so careless in his outlines of the city churches, as delineated in (76) "London, from Southwark Bridge." Poor St. Paul's is sadly flattened.

"The Market Place, Unterseen, the Jungfrau, &c., Switzerland" (152), by W. R. Hardwick, form a glorious group in which the timber construction of the domestic buildings blends capitally with the scenery. Mr. T. H. Crömek has two small drawings which may be described as of *Furniture*, one being an old "Chair of the Doge Priuli, in the Hall at Badger" (92), and the other (173) a view of the "Hall" itself, showing the fireplace: both are in thoroughly debased taste,—that mongrel kind which degrades the noble orders of architecture to frittered and unmeaning purposes. Venice, again, appears in several "Canal" sketches (196, 208, 232, 270), from Mr. D'Egville's pencil, scenes with most of which we have before been made acquainted. "The Baronial Hall, Goodrich Castle" (228), by E. G. Warren, is an excellent subject handled in a masterly manner; as are Mr. J. S. Prout's two large pictures, (253) "St Mackou, Rouen," and (267) "Entrance to McCormack's Chapel, Rock of Cashel, Tipperary," in which the light and shade are capitally managed.

FURTHER THOUGHTS CONCERNING COMPETITION.

Although we neither expressed nor had any intention of returning to this subject so immediately, it is just now exciting so much attention that we need not trouble ourselves to apologise for doing so, while what we have to say is likely to possess greater interest for our readers than it else would.

Much as it needs reform, Competition itself is no inconsiderable reform of, and improvement upon, the previous system of non-competition, when mere favouritism had, we do not say always, but frequently, far more to do with the appointing an architect to a building of more than ordinary importance than any other consideration, as is pretty notorious, and its consequences most unfortunately only too evident. Every now and then we English are taunted with, and reproached *for*, the unsatisfactoriness of many of our public buildings, even those which are doubly entitled to be so called, they being not merely architectural objects exposed to public gaze, but actually paid for by the public.

Thus George IV. inflicted Nash's Buckingham Palace upon us,—by no means improved, although enlarged, in the second edition of it by Blore. He and his architect were allowed to have their own way in the entire matter, without the slightest interference. Now, in the choice of a court poet, even the grossest favouritism does but comparatively very little harm. What though the individual whom royal discernment has exalted to such conspicuous post be an arrant dunce? at any rate, he does not stand in the way of superior talent, or deprive it of the opportunity of displaying itself: on the contrary, his incapacity serves rather as a foil to it. Widely different is it with respect to architecture; in that art the greatest talent is more or less dependent upon adequate opportunity for fully displaying itself, which it is deprived of the power of doing if such opportunity be transferred to another, and should that other be comparatively an incapable, the consequences are truly mischievous. The price that would have purchased success is paid for failure,—art is retarded instead of being allowed to advance,—our taste as a nation is discredited,—and what might have been a worthy object of admiration, becomes perhaps the butt of ridicule. In other branches of art, and in literature also, failures are harmless—at least as far as the public are concerned; those of the pencil remain unsold, or at any rate are not openly exposed to

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decision; and those of the pen and printing-press evaporate from notice by being transformed into waste paper, in which shape they do render the state, as the public, some little service. But in architecture, abortions and miscarriages are no less permanent than patent. Too great precaution cannot, therefore, be taken to guard against them, as is hardly done in the case of our national buildings, that is, those ordered by government to be erected, and for which the nation pays. They, if no others, ought invariably to be thrown open to public Competition, as (rather for a wonder) the Houses of Parliament were, instead of being blindly confided to whoever happens to be at the time the fortunate architect, employé, and placeman attached to the Board of Works; or else one who has sufficient influence with persons in power to be quietly, and without any sort of inquiry as to ability, commissioned and fully empowered to design and execute an important government building—important as to cost, however insignificant and trivial it might be in point of design.

Much as it needs amendment in practice, Competition must be allowed to have done something both for architecture itself and for its followers, if only by breaking up that monopoly which confines all the best opportunities to a few individuals, who do not always make the most of them. It does not appear that it is superior talent which uniformly recommends to official appointments; neither does the security of such position operate as a stimulus to solicitous exertion. Whereas Competition does at any rate give unknown talent a chance for distinguishing itself, although it must be confessed that, as matters are managed at present, it is no more than a mere chance; and such must continue to be the case until the public, that is, those who have a voice in the selection of designs, become not only unaffectedly anxious to make choice of the best, but also capable of discerning which among those submitted to them really is the best. Even since the present Competition system has come up, not a few grievous mistakes have been committed, as has been but too painfully evident on some of the rejected designs being afterwards exhibited, when we perhaps discover that a very common-place design has been preferred to one not only greatly superior to it in every respect, but also superior to many that are themselves of more than ordinary merit. The Architectural Exhibition of 1854-5 afforded a striking instance of the kind, for Mr. Lamb's design for the Town-hall at Preston completely eclipsed Mr. Hill's (the chosen one). Misjudgments of the kind are doubly,—aye, trebly mischievous: the people of the place are deprived of a structure that would confer architectural reputation on their town; original talent becomes discouraged by finding the prize awarded to mediocrity, while the latter feels in the same degree emboldened, and trusts—not without reason—to the want of discernment on the part of committees.

Sometimes, indeed, a committee mistrusting their own judgment, or desirous of shifting responsibility from themselves, refer the matter to a professional man as their umpire. But even that course is not without its objections. Tolerably certain it is, that no professional man would stultify himself by recommending a decidedly poor design; yet, whether he would recommend the best, admits of very great doubt. He is liable to be unduly influenced by professional prejudices and jealousies. On the one hand, he will naturally be prepossessed in favour of the style which he himself practises; on the other, he will not be particularly loud in commendation of a design even in that style, if he perceived it to be treated with greater originality and force than in anything which he himself had done. Unless there be more than one professional umpire on such occasions, too much authority is, we think, given to an individual over his co-professionalists. Whether, in a case of the kind, professional judgment is relied upon implicitly, without good reason being given for the decision it pronounces, we are unable to say, being permitted to learn nothing more than the fact of the decision itself.

"Competition" is, *quæstio vexata*, beset with perplexities on every side, and will, we suspect, continue to be so for some time to come; for though some of the more notorious abuses and grievances might be corrected almost forthwith, years must elapse before our educated classes can become competent judges of architecture as art, and sincere admirers of it accordingly. Hitherto it has been looked upon as lying quite out of the range of general educational study, and as being one so exclusively practical and nothing more, that it may very properly be left entirely to those who make it their profession. Or if it be taken up at all as a recreative pursuit, it is rather as a branch of antiquarian and historical inquiry, than for its intrinsic artistic interest and value. With singularly mistaken policy have architects rather repelled than invited sympathy for their art, by representing it as one the artistic merit of whose productions can be adequately appreciated only by the class to which the producers themselves belong. Even were such really the case, as most certainly it is not, it would be indiscreet to avow it, because it is the non-producers who are the employers,—consequently their taste, be it whatever it may, must be deferred to. And it is almost insulting to ask for patronage, and in nearly the same breath to tell those of whom it is asked that it is all but utterly impossible for them, or any out of the pale of the profession, to acquire a competent knowledge of architecture as art. It would be both wiser and more respectful to say to the public, that although some elementary and theoretical study is indispensably necessary for judging of an art which, unlike painting and sculpture, has no direct prototype or model in nature, the study itself, when divested of all that belongs to practice and execution, therefore concerns only the profession, is far less formidable than it is it interesting—even exciting. That is the view which architects ought to take of the matter, and they seem to be now beginning at least to do so, having, apparently, at last discovered that general ignorance of any of the fine arts, and general indifference to it, are in nearly the same proportion.

So long as a non-professional acquaintance with architecture is the exception and not the rule, we must look for sad and irreparable errors on the part of Competition committees. However, let us hope that the Liverpool Free Library Competition will do much towards bringing about a reform. One important and highly desirable innovation is that of asking for only small sketches in the first instance; since a vast amount of utterly useless labour and, of course, expense also is thereby saved. As was to be expected, an unusually large number of designs—no fewer than 115, have been sent in; yet, though the number of the eventually disappointed will have been increased, the task of each individual will have been lessened very considerably. The example so set will, we hope, become an established precedent; and we would recommend a further innovation, namely, that the selected design should be lithographed and published, and a copy of it sent to each of the competitors.

ARCHITECTURAL DRAWING AND DESIGN.

By W. Stubbs.

[*Abstract of a Paper read before the Liverpool Architectural Society.*]

The principles of design are as important as the mechanical art of drawing to an architect. He makes but a poor draughtsman who does not know the meaning of the marks he puts upon the paper. It is in this case as in poetry—he is the best artist who can express the most meaning in the fewest lines. A great critic has said that "he who talks of the rules of his art is only second rate, and if he talks much he is no artist at all;" but since he writes upon nothing else himself, and promises more, there is some reason to conclude that it is a fascinating subject. There is some universal principle which will please all people in all ages; but the appreciation it will receive depends upon the degree with which the pure feelings for beauty are unpolluted by the dross of fashion and perverted taste. To give names to the several qualities that can be expressed in architecture has long been a fertile source of interest; but it seems as though the numerous terms in use, instead of being conventional signs for things universally agreed upon, are rather like the monuments on a battle field, to point out the places where there has been the most fighting.

The subject of architectural drawing divides itself into two classes—designs made for beauty, and working drawings for constructive plans. Convenience of arrangement in the latter is not a general principle, like the laws of form and colour in the former. The laws of form are less definite than those of colour; and with all their clearness, their mathematical analogy to music, and the universal dogma of prismatic equilibrium, we find in practice that though a pleasing effect cannot be produced by an exact balance of colour, there must be some prevailing tint to give a character to the work. The authorities for the use of colour in classic architecture differ as to the manner of its application. Those who formerly considered it perfect by form alone, were disappointed to find colour at all. The refinements of the minute Grecian curves are practically useless. Masons of the present day make long walls a little hollow, to prevent them

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locking round; but it is not a subject for intense study in either case. Colour should never be used to complete form, but as an additional beauty after the form is perfect. The triangle is better than the square, and two ogees or a flamiform figure better than either. The junction lines of the new portion of St George's Church are the simplest that could well be used with as good effect. For examples of wider application, when the line is one that joins the edifice to the earth, we need only look at the works of the members of our society. In streets and close squares the outline can only be a continental sky-line, broken by dormers and pinnacles; and if a building is detached, proximity to another of different outline will produce perhaps a disagreeable form of void between the two. This may be illustrated by balusters, which should be designed with great regard to the form of the light between them, which is the chief attraction for the eye. [Some methods of producing effective drawings were described at this part of the paper, and the beauty of clear sky opening for the perfection of outline illustrated by a reference to the magnificent appearance of the Town Hall.] Exact imitations of nature are impracticable in the ordinary work of an architect's office. Warm buildings and blue skies are only effective because they are contrasts and complementary, and appear bright on the same principle as that by which Turner's pictures throw out their sunlight. The number of colours available in brickwork are small; but blue bricks should never be used, because the sky and distance are generally cold enough to balance the composition. Tiles as at present used are only addenda, whilst bricks may be worked into the construction. Coloured tiles were used in France in 1530, upon the Emperor Francis's palace of Madrid. The facings of street architecture might be cheaply decorated by moulded and coloured bricks. Shop fronts should be designed to attract attention by their individuality, but this is lost by one front verging into the next. One or two in town are unusually prominent, by returning to a fairly proportioned window on each side of a moderate door. Construction is sometimes forgotten in drawing for appearances; elbowed voussoirs and other objectionable instances are observed.

In referring to the legends of natural types for the orders and styles, it is suggested that the Corinthian capital originated in some such custom as our own of tying evergreens round the columns at games and festivals; the upright leaves, the bead, and caulieuli seem to point to this. The Grecians and Egyptians lavished their art upon their temples, whilst our chief excellence is in the perfection of dwellings. To obtain light and fresh air are great points. A canon has been laid down by which 100 feet of cubic contents in a room should have 1 square foot of lighting aperture; but the same size of a window will light the room better from the end than the side. Bas-relief or sculpture should not be placed opposite the light; but this is the best place for pictures or hangings. The plaster work of an apartment should be designed with great regard to the position of the light, and the plaster casts exhibited in different positions are illustrations of this. A cornice is particularly referred to, as designed to derive its beauty from light cast upwards. The lower moulding casts a shadow against which the light pattern upon its edge is shown to advantage. The old cornice copied from the classic exteriors should be lighted from above, which is not the case in a room. Ceilings should have little ornament, but if any it should be small and plain. Animated figures and other suggestions of life should not be used in such unnatural positions, especially if above the natural size, as the eye always uses the human form as a standard for the magnitude of a room. A number of methods are mentioned of increasing the apparent dimensions, and adding to the beauty of apartments; and it is suggested that architects should have more control over the finishing of a house. Although little is said of the mechanical practice of drawing, it is of importance that the architect be master of his pencil, for directions to his draughtsmen will never convey the feeling to a curve that there is in one sketched at a sweep by his own hand, like the track of a swan in the water. It is probable that the more complex forms of beauty may derive their qualities from some invisible curve that floats about their point. Objects that appear out of place always do so, because they attract the eye out of a smooth, graceful track; for, like lightning, the eye of taste will take the most direct line of conductors, and a rupture takes place at every undue interruption. The powers of projections and light parts for attracting the eye, and the influence of colour or tones to increase or modify that power, are the two grand points for study.

ARCHITECTURAL IMPROVEMENTS OF LONDON, No. III.

At the conclusion of our second paper on the above subject (*ante* p. 144), we made some remarks upon the Panopticon in Leicester-square; in continuation of which, we may observe that Minton's vitrified tiles are very extensively employed on the principal elevation of that structure, with considerable success; but we must emphatically protest against the barbarity of covering the brickwork with cement, and jointing the mouldings, as if they were executed in wood instead of stone. In the façade of this building, all sorts of windows are introduced with impunity, such as square and round headed, pointed, horse-shoe-shaped, and double semicircular, forming a whole as discordant and unharmonious as could well be devised. As for the entrance-portal, it is remarkable for ugliness and constructive impropriety as regards its arch, whilst the formation of some of its coloured accessories on the walls is extremely beautiful.

In continuation of that class of buildings in which polychromatic combinations are employed, we may direct attention to another example in Tottenham-court-road, which has recently been built for Messrs. Heal and Son. In this edifice the Italian style is adopted, and a considerable amount of colour introduced in the pilasters, panels, and in the frieze of the main cornice, by the insertion of Minton's tiles; somewhat overdone, however, and too much cut up into small parts, particularly in reference to the panelled piers between the upper windows. The great staring pateræ inserted in the frieze are also highly objectionable.

In our concluding enumeration, at present, of edifices recently erected with mixed materials, as coloured bricks, cements, &c., we may also include the "Royal Exchange buildings," and the structure occupied by the Scottish Amicable Life Assurance Society, both of which are situated opposite the eastern end of the Royal Exchange. The plain surfaces of the former present a very favourable specimen of dark red brickwork, entirely free from the efflorescence which sometimes disfigures this kind of work. The basement is in stone, and the dressings of the windows, together with the principal cornice at the eaves, are in Portland cement. The design of this cornice is somewhat startling, in reference to the excessive depth and projection of the blocks or modillions introduced to support its corona. The latter building is in the Renaissance style, very showy and fantastic; exception must especially be taken to the multiplicity and extreme smallness of the windows, which detracts very materially from the dignity we wish to see in all edifices the designers of which aim at effective superiority.

Another very important edifice recently erected, in which the mixture of coloured bricks, stone, and cement, is employed, is an imposing pile situated at the eastern end of St. Paul's churchyard, erected for Messrs. Cook, Son and Co, from the designs of Mr. Knowles, of Raymond's-buildings, Holborn. The extent of the frontage of this building is 171 feet, the depth of the eastern wall next Cannon-street 57 ft. 6 in., that of the western end 91 feet, and the height from the pavement to the top of the main cornice, exclusive of the blocking, is 73 feet. The entrance-doorway and basement-story are of Portland stone; the plain facings of the superstructure are composed of white Suffolk bricks; and the panels, stringcourses, and margins introduced beyond the bounding lines of the quoins, are red brick. The style of architecture is Italian, very successfully applied, both as regards substantiality and dignity of effect, such as we have had pleasure in commending, on a former occasion, in a block of buildings recently erected at the corner of Arundel-street, Strand. The internal arrangements of these vast business premises are very remarkable, embracing every convenience for carrying on the extensive operations which are transacted within their walls. The whole area of the basement, ground, first, and second-floors, are devoted to business purposes, and are open throughout, exclusive of the intervention of partitions, the support for the various floors being effected by means of hollow cast-iron columns, the head of each column being socketed into the base of that immediately above. These columns are connected by girders, which form a perfect iron frame-work underneath the floor of each story, and bind the whole together, being rivetted securely both vertically and horizontally. The light for the several areas is obtained partly from the side-walls, but mainly from a large elliptical aperture technically called a "well-hole," forming a vacant space in the centre of the building from the basement to the roof, diffusing an ample volume

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of light around the central areas of the various floors, and exhibiting goods to great advantage. The coloured decoration of the walls and ceilings of the interior deserves especial commendation, for the charming effect produced by the judicious combination of three simple colours, without the aid of tawdry gilding or meretricious superfluity. The general plain surfaces are drab, relieved in the panels and ground-work of the enriched portions by lilac, with the occasional and partial relief of red. The main building is connected by an open cast-iron lattice bridge, and a tunnel underneath Little Carter-lane, communicating with a second pile of warehouses, which are more especially devoted to the residence of the employées of the establishment, and for housing heavy goods. The counting-houses and packing departments are on the ground-floor, screened off by an ornamental glazed panelling from the rest of the area on this level. One very important apparatus, called a "lift," is also fitted up at one end of the premises, which saves a considerable amount of manual labour. This contrivance is worked by a steam-engine of 8-horse power, situated in the basement, and delivers goods and passengers at the various floors. The waste steam from the boiler of the engine is also economised and passed into coils of pipe disposed immediately below the well-holes (previously alluded to) which open through the several floors to the upper level, and so warms the whole building effectually and simply, sending up warm columns of air, which stream off and are diffused throughout every floor, as they rise through the several wells. These highly important premises were erected by Mr. John Willson, of Great Suffolk-street, Southwark, the work being executed under a schedule of prices, and amounting in all to about 50,000*l.*, which sum included a portion of the fittings.

Leaving for the present those buildings which are constructed of variously coloured materials, we shall now proceed to notice some of those in which stone only is employed in their principal elevations. Among this class is a very prominent example, which forms one of our City improvements, and has recently been erected in Wood-street, Cheapside, for Messrs. Munt, Browne and Co., from the designs of Mr. Somers Clarke, Buckingham-street, Adelphi. The structure in question consists of six stories above the street level; this great altitude being resorted to in order to obtain extra bed-rooms on the upper floors for the accommodation of the numerous assistants required on the establishment at certain seasons, when their attendance is necessary late in the evening. The frontage in Wood-street is 81 feet, its depth 96 feet, and the height of the street elevation to the top of the principal cornice 86 feet. The façade is entirely faced with Portland and Bath stone, backed with brick. The design appears to be based upon the characteristics of the French Renaissance style, the windows having moulded mullions, which divide them into two equal general lights from top to bottom, and altogether the building possesses certain distinguishing features, diametrically opposed to the system laid down by Palladio and his followers. The chief entrance is by a loggia, remarkable for its peculiar details and the very great amount of elaborated stone-carving bestowed upon it externally, and its internal decorations in Parian cement. The arrangements of the uppermost windows are singular, inasmuch that they are elliptical in shape, and are inserted longitudinally in the frieze of the main cornice, being separated from each other by trusses in pairs, in conjunction with modillions or small cantilevers which support the corona of the cornice. The interior is fitted up in the most complete manner, replete with every convenience required for a most extensive wholesale millinery establishment; one of its constructive features most especially worthy of notice, is the introduction of *wrought-iron girders*, on the boiler-plate principle, by which great extra strength and security is obtained, and the number of supporting columns greatly reduced. These girders rest upon fluted cast-iron columns, 16 ft. 6 in. long, and 10 inches diameter, with enriched capitals; the columns are bolted together through square hollow boxes cast with them, and which carry the bases of the columns immediately above. The ends of four of the girders come in conjunction together at the top of each column, are then securely bolted together, the corresponding ends being pinned into the main walls with brickwork set in cement, forming a combination of united strength, which is calculated to sustain one-fifth part more weight than they will ever be required to bear. These columns and girders were executed by Messrs. Miller, of Blackwall, from drawings furnished by the architect, and form admirable specimens of clean, sharp castings of very heavy calibre. Messrs. Lucas, Brothers, of the Belvedere-road, Lambeth, were the contractors for the works, whose original estimate, including 3000*l.* for fittings, was 16,433*l.*, which, with additional works and fittings subsequently contracted for, brought the total outlay to nearly 20,000*l.**

THE MUSEUM BUILDING ON THE KENSINGTON GORE ESTATE.

In the above structure we have another of the many illustrations of the blundering of our government commissioners and "practical art teachers," in the outlay of money, and the erection of a building that will tend still further to disgrace us as a nation, in reference to our public edifices. Surely never was conceived such a monstrosity, as the commissioners of the Great Exhibition have sanctioned to be erected at Kensington Gore, which may not inaptly be likened to a huge lugubrious hospital for decayed railway carriages, railway workshops, or locomotive stabling. With the designers and constructors of the building we have no fault to find, for no doubt they have only acted up to the instructions that they received, which we presume must have been to design and erect a structure for a certain purpose, to cover the largest space of ground at the cheapest possible rate. This railway shed, or whatever it may be called, is rectangular in plan, 266 feet long by 126 feet wide and 40 feet high. It is divided transversely into three divisions of equal width, length, and height, and each covered by segmental roofs of corrugated iron. In the construction of the walls, cast-iron uprights are employed, inserted in a foundation frame-work of timber, resting on masses of concrete 3 feet deep. Light is obtained from three skylights 12 feet wide, which run the whole length of the three roofs covering the three divisions of the building. A gallery runs round the whole interior, 42 feet wide at the sides, and 21 feet wide at the ends, supported by longitudinal and cross girders, joists being fixed between the latter to which the flooring is nailed. The whole surface available for the various works intended to be exhibited (including the lower floor and galleries), will comprehend an area of 6400 yards. The structure with its fittings is estimated to cost 15,000*l.*, and was designed and constructed by Messrs. Chas. Young and Co.; the supervising commissioner being Sir William Cubitt. It would appear that the excuse for the ugliness of the building, is that it is merely temporary; and yet, in contradiction to this, the Board of Trade report to the Treasury says, that "*it will at all times* and for a *lengthened period* prove of much service." That a *temporary* shed is to be of much service for a lengthened period certainly seems rather paradoxical.

The crowded state of our columns debars us at present from entering fully into this deplorable subject; but we must condemn the absurdity, waste of money, and, still worse, the injustice to the public, in the erection of this so-called museum on its present site, even if it had been ever so beautiful; for should it really be true that the contents of Marlborough House, and other collections of art, are to be conveyed there, it may be asked, how are artizans and others to spare either time or money to traverse several miles into the outskirts of the metropolis for the purposes of study? It surely would have been a more judicious step if, instead of throwing away some 15,000*l.* or 20,000*l.*, the commissioners had divided the collection at Marlborough House (cart-loads of which are, we believe, laying in the cellars of that establishment), and housed the casts and other specimens in convenient localities in London, where art-workmen, artizans and others, might have had access to them within half-an-hour's walk from their homes; and not transported them to Kensington Gore, where they will be next to valueless to those who most require to be benefitted from their study. By judicious and economical management, the sum now being so recklessly wasted would have procured four suitable places similar to those to which we have adverted; and the good results which would have arisen from such an arrangement, it is believed are unquestionable, in an educational point of view, in comparison with the abortive scheme which is now being perpetrated so unwisely.

* Numerous details of this highly important structure (to a large scale), are published in this month's number of Mr. Laxton's 'Examples of Building Construction.

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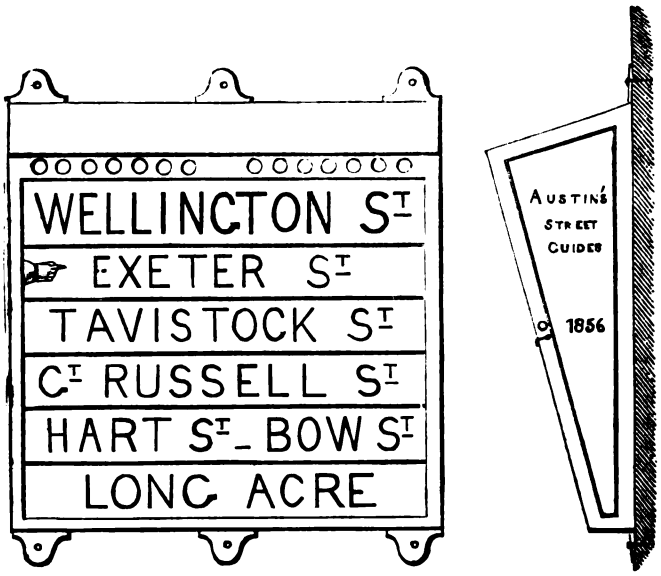
AUSTIN'S STREET INDICATOR.



This invention consists of a strong cast-iron rebated frame, with doors to open at each end for lighting or extinguishing gas. The front panel is filled with alternating strips of coloured and ground glass, having names of streets on them which show out white on a dark ground by day, and at night the whole becomes a pretty and attractive party-coloured panel, the letters having a silvered appearance; forming street-lamp and guide at the same time. The above Indicator is fixed at the corner of Wellington-street and the Strand; the name of the street being shown in large letters at the top, and the streets branching from it in smaller letters, below.

ST. JOHN'S CATHEDRAL, SALFORD.

Messrs. Weightman, Hadfield, and Goldie, *Architects.*

(*With an Engraving, Plate* XVII.)

We this month continue our illustrations of Salford Cathedral, by the Lee chantry, which occupies the eastern end of the northern choir aisle; and here again are enduring memorials of individual liberality. While, in general character, the parcloses, the altar and reredos, and the founder's tomb, correspond with those of the Leeming chantry, they all differ in details and general ornamentation; and the tomb differs also in position, not being in the screen or parclose between the ladye-chapel and chantry, but in the outer north wall of the chantry. All their ornamentation is full of originality of design and of excellent workmanship. The tomb is an exquisite example of sculpture, and we may question whether any of our old cathedrals could produce examples of middle age work to surpass the crockets and spandril fillings of this monument. It consists of a raking canopy, with crockets and finial on which is throned our Lord displaying his wounds. This canopy encloses a cusped arch, beneath which is an exceedingly elaborately engraved brass, of a totally different character, however, from that in the Leeming chantry. It is what is technically termed a "cross brass," and is apparently of the thirteenth or fourteenth century style. It consists of a large floriated cross, each arm terminating in a sort of trefoil, standing on a calvary of six steps, and having suspended on its stem a large square label, to receive the future monumental inscription. In the large central spandril of the arch of this tomb is a trefoil, intersected by the triangle, the emblem of the Trinity. Within this is a sculptured rose-tree, with roses amidst the foliage; and suspended on its branches is a shield, blazoning the arms of the Lee family, —Argent, a fesse sable, between three crescents of the second.

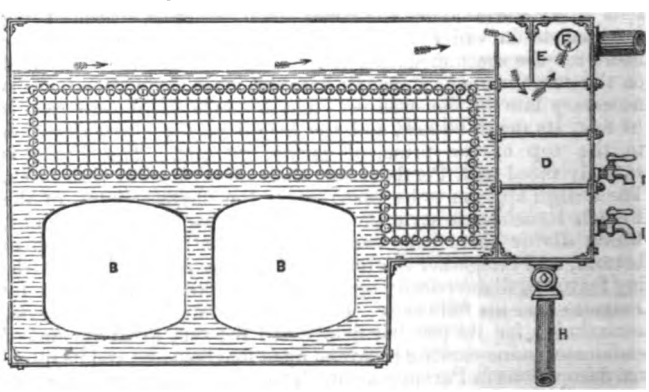
A stringcourse along the north wall is interrupted by the tomb, and the stringcourse terminals are two angels looking up to our Lord, on his throne of glory at the apex of the tomb. Within the canopy, the spandrils of the cusps are filled with emblematic carvings, including the rose—the passion-flower, with birds—oak-leaves and acorns, with a squirrel in the foliage—the hawthorn, with birds—the vine, with birds pecking at the grapes—and the ivy, with its berries and birds. The circular cusps are richly carved, and the whole of these designs in flowers, fruit, and foliage are sculptured with great delicacy and taste. The altar and reredos are of original and striking design. The latter is a composition of three arches, within which are reliefs of the patron saints of the founder and his family. The central arch, representing the Virgin throned, has been much admired for its chaste sculpture.

The relief in one of the outer arches represents St. Patrick training the youthful founder, and bringing him towards the Virgin. The other relief represents St. Catherine instructing the two female members of the family. Above are the monograms of these saints. Below runs a line of deeply-sunken quatrefoils, each containing a half figure of an angel amongst sculptured foliage, and playing upon various musical instruments. The altar frontal is delicately sculptured in an arcade of panels filled with diaper work, and terminating in lilies and roses. The floor of this chapel, like that of the Leeming chantry, is richly paved in mosaic and encaustic tiles, a combination which we do not remember to have seen before, but which is most satisfactory in its result.

REVIEW OF NEW INVENTIONS.

Marine Boilers.

Mr. George Rennie, of the firm of Messrs. Rennie, of Holland-street, Blackfriars, has entered the numerous list of inventors of boilers, and has patented "improvements in steam-engine boilers as applied to the propulsion of vessels." The object he has in view is to construct a marine boiler of the least possible height, without having the inconvenience of "priming." To effect this object, the steam chamber is attached to the side or end of the boiler, or it may be within it. In the arrangement shown in the drawings accompanying the specification, the chamber is placed at one end as represented below, in longitudinal section. The



spaces B, B, are the furnaces placed athwartship; D, is the steam chamber with its requisite stays and a screen E, to prevent the water from being carried off with the steam into the steam-pipe F. The more effectually to drain the steam from water before it enters the steam-pipe, two or more of such screens are recommended to be used. There are two guage-cocks I, I, for ascertaining the height of the water, which is constantly collecting in the chamber, and may be expelled through the blow-off pipe H. The operation of this boiler is clearly indicated by the illustration. The inventor claims, "the addition of a chamber in which the steam is freed from the water which would otherwise be carried over with it, and by the use of which chamber lower boilers may be used on board of vessels of small draft." By the use of several screens for the steam to impinge against before it enters the steam-pipe, the object aimed at may be satisfactorily accomplished. There must, however, be a considerable quantity of water carried over into the chamber, the blowing off of which would involve a loss of heat, and so far detract from the value of this arrangement. The same effect of drying—or rather, of draining—the steam before it enters the cylinder, might, however, be attained more conveniently without increasing the height of the boiler.

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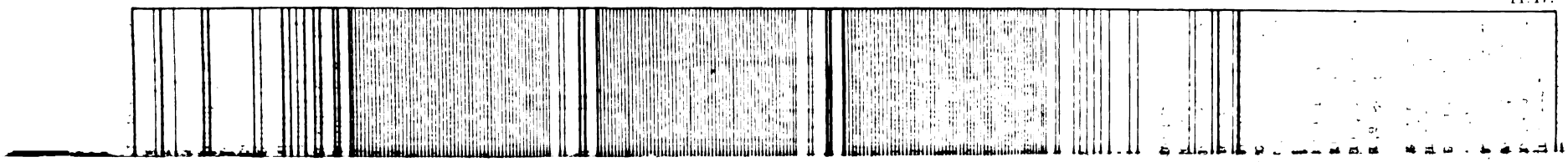
The Lee Chantry. St Johns Cathedral. Salford.

Elevation Plan & Section of the Altar.



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Cellular Boiler, and Centrifugal Blast-Valve.

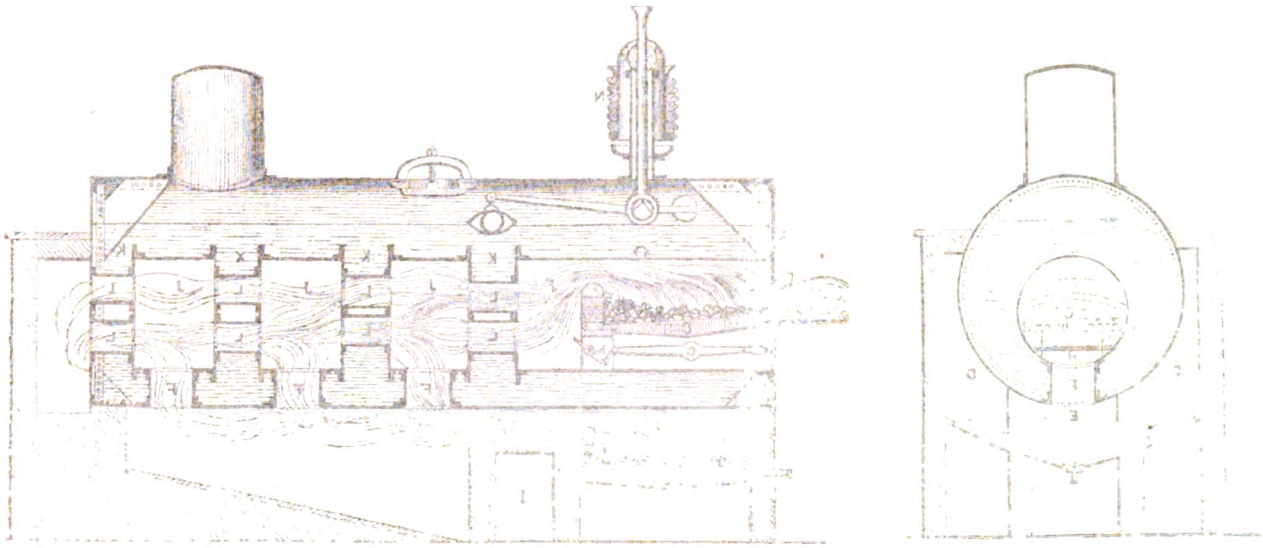

Fig. 2.

Fig. 1.

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Cellular Boiler, and Oscillating Safety-Valve.

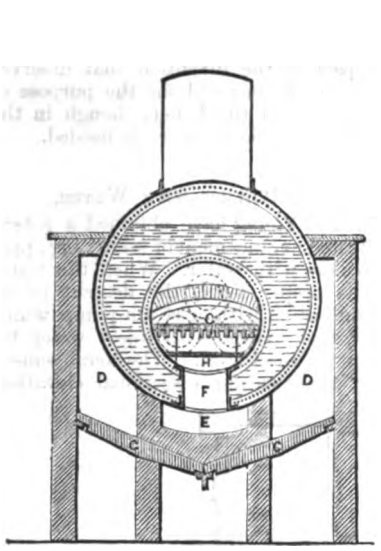

Fig. 1.

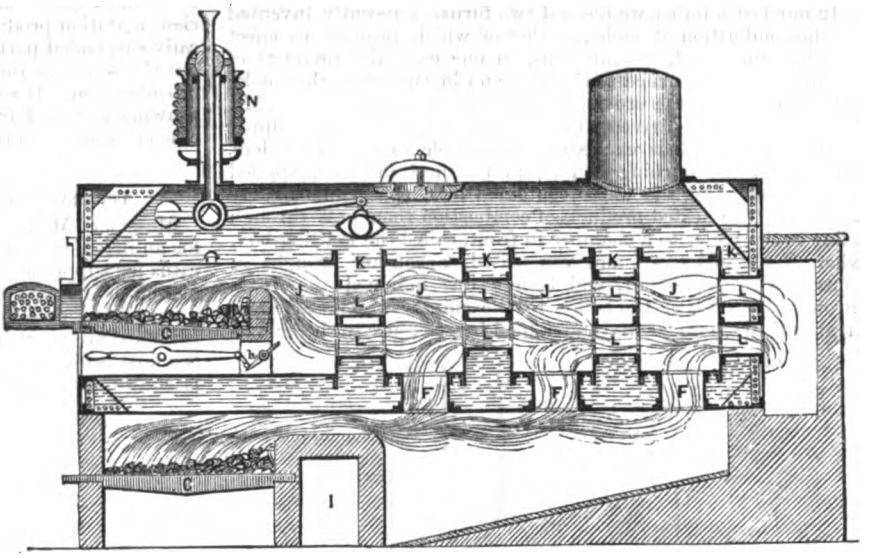

Fig. 2.

Mr. T. Cowburn has patented a new construction of boiler for stationary steam-engines, in which he increases the heating surface by an arrangement of two furnaces, one of which is placed in the middle of the boiler and the other at the bottom. He also conveys the heated products of combustion through return flues at each side, and by this means all parts of the water space of the boiler are surrounded by heat. In the accompanying wood-cuts, fig. 1 represents a cross section of the boiler, showing the upper and the lower fire-grates C, C, C, C, the position of the internal furnace and flues, and the longitudinal return flues D, D, with one vertical pipe flue F. The tube plate wing-stays that secure the parts to the shell of the boiler have been omitted to avoid confusion. Fig. 2 is a longitudinal section showing the swing door A, in the upper fire-bridge, for the two-fold purposes of admitting a due supply of air, and of removing the ashes and flue dust. The bridge of the furnace under the boiler is hollow at I, to admit of the return flue current passing from one side of the boiler to the other. The internal flue consists of a series of compartments, or cells J, J, between which are the water spaces K, K, penetrated by a number of short wrought-iron pipes L, L, that connect and secure each portion of the internal flue, longitudinally, with one another, and with the ends of the boiler. Each chamber or cell is also connected with the bottom of the boiler by a series of vertical flue passages F, F, which admit the products of combustion from the lower fire, and allow the flue dust to precipitate into the spaces beneath. The pipes placed between the fire-box and the first cell are three in number (represented by dotted circles in the cross section fig. 1), one of which is placed over the two others, for the purpose of inducing the flames to descend after passing over the bridge, and to intercept the flames from the lower fire at the bottom of the first cell. The flames, being thus united, rise to the *top* of the second cell, as the second series of pipes are arranged in an inverse position to the first (two placed over one), pass through them, again receive additions from beneath, and undulate and intermix in their passage from cell, through pipe to cell. The united products of combustion are thus made to pass through the water previous to their combined return by the side of the boiler, and a considerable addition of heating surface is thus obtained *under* the boiler.

By this arrangement, it is evident that the heating surface is considerably increased, and when a rapid supply of steam is required from a small boiler, regardless of the consumption of fuel, there would be much advantage gained from this plan, provided the complication in the structure were not found inconvenient and expensive. The double furnace would consume nearly double the quantity of coal, and it is very questionable whether it would generate double the quantity of steam. In point of economy, therefore, there would be a loss instead of a gain by this contrivance, to which the inventor has given the name of "cellular boiler."

There is attached to the boiler the "oscillating safety valve" invented by Mr. Cowburn, and shown in section in fig. 2. This safety valve N, consists of a ball-valve, shown near the top, resting upon the end of a pipe to which it fits steam-tight when held down by the weight. The ball is weighted by rings of cast-iron that hang below the seat of the valve, by which the latter is self-adjusted, and as the steam escapes, impart an oscillating motion, which according to the inventor's description "preserves the good fit of the valve." In addition to the provision for the escape of steam when the pressure is too great, there is a contrivance for giving notice when the level of the water is too low. A small pipe inserted vertically into the boiler passes through the ball-valve. The lower end of the pipe is closed by a swivel valve kept in its place by a float on the water. When the water in the boiler gets too low, the float descends and opens the valve, and the escape of steam through the pipe gives warning of the want of supply. We apprehend that the friction of the pipe in the hole of the ball, would be liable to obstruct the free action of the valve, but we understand that a large number of these safety valves have been practically applied with good effect.

A Water-Level Indicator.

A patent has been obtained in the name of R. A. Brooman, for an invention communicated by a foreigner, the object of which is to indicate the level of water in steam boilers. The invention, it is stated, may be also applied to feed the boiler with water, so as to maintain it at the same level, but the method of doing so is not claimed as part of the invention. The plan of indication proposed is, however, merely fanciful, and would be altogether worthless as an indicator. The contrivance consists in placing a coiled tube inside a hollow horizontal projection from the boiler, placed at the proper water level, one end of which coil passes out vertically through a steam-tight joint, and the other end passes out horizontally. Two tubes, inserted into the boiler, one above and the other below the proper water level, communicate with the horizontal chamber, so that when the water in the boiler is too low, the water runs out and the chamber is filled with steam. It is assumed by the inventor that the water in the boiler is much cooler than the steam, and that when the water has run out of the horizontal chamber, and its place supplied with steam, that the water contained in the coil will become heated and generate steam, the elasticity of which may be applied to sound a whistle, or to do various other things to indicate that the water in the boiler is too low. As the operation of this curious contrivance would entirely depend on the assumption that the water in the boiler would not communicate heat to the coil, whilst steam would immediately do so, we need say nothing further of its merits. The invention is, indeed, only worth notice as evidence of the want of proper examination at the Patent Office, in order to avoid the grant of patents to impracticable schemes.

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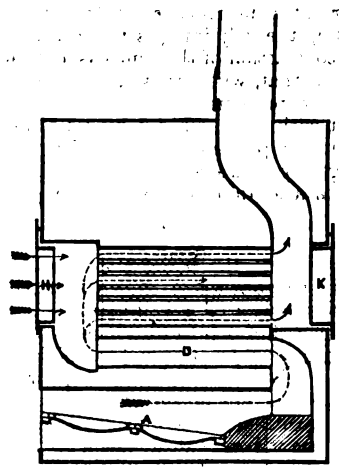
Steam-Boiler Furnaces.

In our last number we noticed two furnaces recently invented for the combustion of smoke, neither of which promise to effect the object proposed, inasmuch as, in one case, the products of combustion are returned to the fire; and in the other, the smoke is heated without the provision of air to cause its ignition. Mr. Lee Stevens has contrived a furnace especially adapted to supply the latter want. It is exclusively applicable to tubular boilers. The heat of the burning fuel is, in the first instance, applied directly to heating the water contained in a space immediately above it. The heated products of combustion then pass through a flue in the boiler to a chamber in front, called the igniting-box, where the heated gases and vapourised carbon are brought in contact with jets of air, and being thus inflamed they pass through the tubes of the boiler to the chimney. The arrangement will be more clearly understood by reference to the accompanying wood-cut, representing a longitudinal section of a furnace constructed with the water-space immediately above the fire. The fire-places are shown at A, the heated smoke passes through the flue D, and returns to the chamber in front, where a number of small openings, indicated by the horizontal arrows, admit jets of air, by which the inflammable gases and the carbon are ignited, and pass on in the direction of the arrows through the tubes. There is a door at each end of the boiler, at H and K, to facilitate the cleaning of the tubes. This invention is a convenient modification of the principle that has been previously applied by Mr. Williams and others, and there is little doubt would answer the purpose intended. The main question to be determined is the very perplexing one whether the arrangement is sufficiently distinct from others to entitle it to be considered new; and in the settlement of that point the respective inventors, rather than the public, are the parties interested.

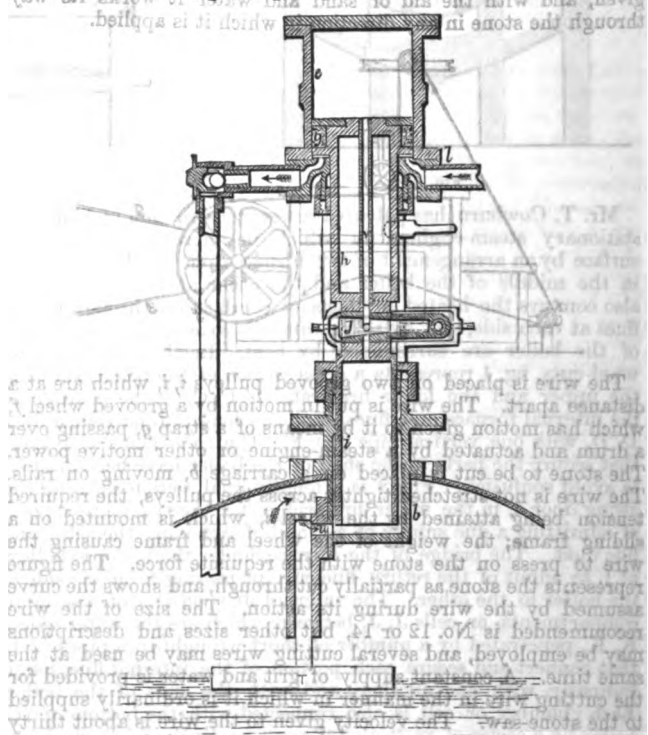


Prevention of Incrustation.

Mr. E. Topham, of Nottingham, has obtained a patent "for apparatus for cleansing out the sediment from the water in steam boilers, and preventing incrustation of the same." The plan adopted by Mr. Topham is to keep the water in the boiler in a state of agitation by the action of a series of scrapers arranged near the bottom, and to blow out the sediment occasionally through a perforated pipe placed along the boiler, connected with a vertical pipe that passes through the top and empties into a culvert. It is stated to be an important feature of this invention, that the perforations in the pipe are less, taken collectively, than the area of the opening of the outlet cock, by which means the water continues to enter at every portion of the pipe throughout its whole length, instead of entering only at the apertures nearest the outflow-pipe, as it otherwise would. It is unnecessary to describe more fully the construction of the apparatus, and the means devised for keeping the scrapers in action, further than to say it is proposed to work them by means of a connecting-rod passing through a stuffing-box, to be either occasionally moved by hand, or attached to some part of the machinery of the engine. The agitators would, indeed, be useless in the case of salt water, the incrustation from which is the most troublesome; and it is questionable whether they would be of service in any other circumstances. The super-saturation of the water with salt would occasion incrustation despite of the agitators, and there is sufficient agitation produced by ebullition to prevent merely mechanically suspended particles from depositing. The pipe for blowing out the water is the only part of the invention that deserves consideration. It seems to be well contrived for the purpose of drawing water off from both ends of the boiler, though in the case of super-saturation such a provision is scarcely needed.

Apparatus for Supplying Boilers with Water.

Messrs. S. Mellor and Thomas Young have obtained a patent for an ingenious but complicated arrangement of self-acting apparatus for supplying steam-boilers with water. When the water in the boiler falls below its proper level, the descent of an internal float opens a communication with a steam-pump which is immediately put in action, and continues to inject water till the float is again raised to its required level. The arrangement is shown in the engraving, representing a sectional elevation.



There is a lower and an upper cylinder, *b* and *e*, in which hollow plungers, *h* and *i*, work through stuffing-boxes; and in the upper cylinder there is a piston *g*. An inlet-pipe *l*, connected with supply of water, enters into the cylinder and an eduction-pipe in communication with the boiler, so that the action of the piston pumps in the water. The drawing shows the position of the apparatus when the water is at the proper level, and it is not in action. As soon as the level is lowered, the float T descends; an arm connected with it opens the passage *u*, for the admission of steam to the interior of the lower plunger *i*. The two plungers and the piston *g*, connected with them, are those forced upwards. The steam that was contained in the cylinder *e*, escapes through the pipe *v*, and the water from the supply-cistern enters the cylinder through the pipe *l*. When the piston has arrived at the top of the cylinder, a three-way-valve at *j*, is turned by an arm that strikes against a stud as the plungers ascend, and the steam is admitted above the cylinder, and it is allowed to escape below it. The motion is then reversed, and the piston descends, forcing the water beneath it into the boiler through the pipe *m*, suitable valves being placed on the pipes *l* and *m* to admit and to retard the passage of water at the times of injection and eduction. The valve *j*, is worked by a hollow lever containing mercury, so that when the stud that lifts it has raised it above the horizontal line, the mercury flows to the other end, and turns the lever more completely round, to effect the reversal of the action. The pump will continue working in this manner until the float inside the boiler rises sufficiently to close again the aperture at *u*.

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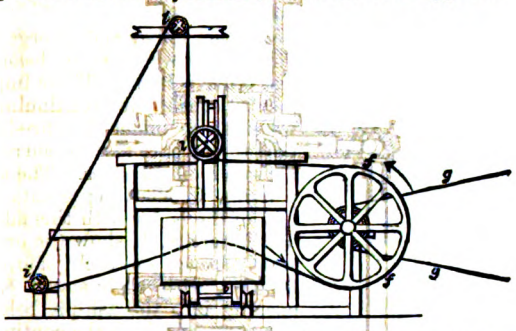
This contrivance is, we apprehend, more ingenious than practical, as it brings into action complicated machinery for effecting an object that may be accomplished in a much more simple manner. Assuming the internal float to be always in a good working condition, the proper level of the water in the boiler might be maintained by its direct admission from the source of supply without the intervention of so complicated an apparatus.

Cutting Stone.

A patent has been granted to Charles Manby, of Great George-street, Westminster, and William Piper, of Stangate, for "improvements in machinery for cutting stone." This invention is one of great promise for the purpose for which it is intended. The tedious process of stone-cutting by the ordinary saw certainly calls for improvement, and the plan contrived by Messrs. Manby and Piper seems to answer the call. The cutting implement they employ is an endless wire of soft iron, to which a rapid motion is given, and with the aid of sand and water it works its way through the stone in any direction in which it is applied.



The wire is placed on two grooved pulleys *i*, *i*, which are at a distance apart. The wire is put in motion by a grooved wheel *f*, which has motion given to it by means of a strap *g*, passing over a drum and actuated by a steam-engine or other motive power. The stone to be cut is placed on a carriage *b*, moving on rails. The wire is not stretched tightly across the pulleys, the required tension being attained by the wheel *l*, which is mounted on a sliding frame; the weight of the wheel and frame causing the wire to press on the stone with the requisite force. The figure represents the stone as partially cut through, and shows the curve assumed by the wire during its action. The size of the wire recommended is No. 12 or 14, but other sizes and descriptions may be employed, and several cutting wires may be used at the same time. A constant supply of grit and water is provided for the cutting wire in the manner in which it is ordinarily supplied to the stone-saw. The velocity given to the wire is about thirty feet per second. The patentees do not state in their specification the quantity of work that can be done by their improved machinery, but there can be little doubt its action is far more rapid than the saw, and it possesses also the advantage of being able to cut the stone to any required curve.

Pumps.

In the specifications of most American patents, the inventors express their own estimate of the great value and utility of their inventions, nor is the specification of Mr. William T. Vose, of the state of Massachussetts, for "new and useful improvements in pumps for elevating fluids," an exception. The patent is, however, useless, for few persons will be disposed to dispute his claim to an invention which would have no other effect than the increase of friction; and though patented in this country as well as in the United States, it deserves notice more for its curiosity than its usefulness. The pump is constructed of two barrels placed together side by side, in each of which there is a separate piston. These two cylinders are connected at the top by a bent tube, through which tube the piston-rods work; each one being provided with a stuffing-box. At the bottom of one cylinder the water is admitted, and at the bottom of the other it is forced out, both pistons being raised and depressed at the same time. The "important feature of the invention," is the arrangement of the valves in the pistons, one of them being made to open upwards and the other downwards. In the action of this pump, when the pistons are raised, the water that had been admitted through the valve of one piston is lifted up and forced through the valve of the other; and, in descending, the water is forced out by the second piston whilst it is being admitted above by the other. By this means two pistons, with separate stuffing-boxes, are required to do the work that might be equally well or better done with one. We are at a loss, indeed, to conceive what possible advantage the American patentee expects to derive from such "new and useful improvements in pumps for elevating fluids."

Metallic Packing for Pistons.

A patent granted to Charles Van den Bergh, of Lacken, Belgium, for an invention for packing piston-rods, promises to be of service in solving the difficult problem of making the piston-rod of an engine steam-tight, with the least possible friction. The invention is described to consist of a peculiar construction of bronze or other flat metal rings, so contrived that when one set of rings expand, the adjoining set contract. This alternate expansion and contraction of the rings is produced by the shape given to them, so that, when they are screwed down together, the expansion by pressure on one set of rings contracts the rings in contact with them. Fig. 1 represents a piston-rod with its annular metallic packing, as fitted for working; fig. 2 is a plan of the rings; fig. 3 is a section of one pair of rings, hollowed out; and fig. 4 is a section of another pair of rings, which are

Fig. 1.

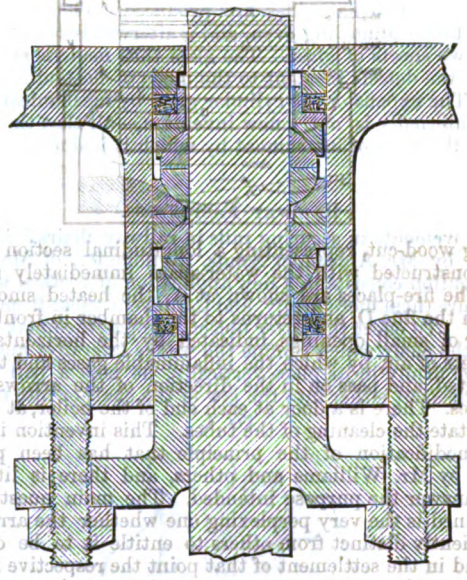


Fig. 2.

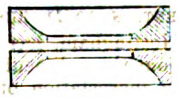


Fig. 3.

Fig. 4.

bevelled or rounded off on one side, so as exactly to fit into the hollow of the other rings, each of the rings having a slit in it so as to allow it to expand or contract. The rings are arranged in pairs, with their flat sides together; and alternate pairs are laid upon one another with their slits reversed in position throughout; they are then screwed down, as shown in fig. 1. To prevent the packing from pressing unduly on the piston-rod, it is found necessary slightly to diminish the circumference of the concave rings to afford them some play. The whole of the packing, it is stated, may be placed between two pairs of rings, each forming a box, opening towards the outside, containing an india-rubber or other suitable washer. The novelty of the invention claimed by the patentee consists in the property of the wedge-like form of one pair of rings fitting into and expanding the dished pairs of rings—the bevelled rings contracting proportionably. This arrangement seems to attain the object so much desired of having

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a metallic surface for the piston-rod to work against, with the power of contracting the aperture as the metal wears away. The practical difficulty attending it, will be to make the packing sufficiently steam-tight. The provision of an exterior box with india-rubber washers, shows that the inventor has felt this difficulty pressing upon him.

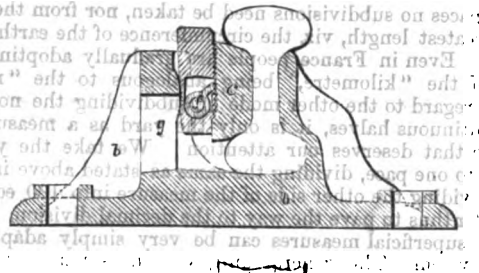
Flattening Glass.

In the usual method of making sheet glass, the glass is first blown into the form of large cylinders, which are afterwards slit from top to bottom. The cylinders are then placed in a flattening furnace with the slit uppermost, and as the glass becomes softened by heat the slit opens, and the cylinder expands until the glass lies flat on the floor of the kiln. By this process of flattening, there is great risk of burning the glass, and its surface is more or less wavy and uneven. A patent has been obtained in this country by W. Penn Walter, of Philadelphia, for "improvements in flattening cylinder glass," by which the operation is performed by mechanical means, and the "cockling" of the glass is avoided. The implement he employs consists of an iron or steel rod with expanding wings, which open and close in the same manner as the ribs of an umbrella, by pushing up and drawing back a slide on the rod. Two or three pairs of ribs are attached to the rod, with side pieces connected to the ends so as to open parallel. This implement is introduced into the cylinder when in the flattening kiln, and as the glass becomes heated the wings are expanded till two flat sides are produced. The glass is then removed to the annealing oven, and is afterwards cut at the edges to form two sheets of glass. The glass thus made is stated to be free from the defects incident to the mode of flattening by gravitation. The expansion of cylinder glass by mechanical pressure applied internally is not a new invention,—all that the patentee claims is the form of instrument by which it is done.

Railway Fastenings.

"Improvements in securing rails in railway chairs," have been patented by Mr. Alexander Sands, ironfounder, of Manchester. This invention consists in a new application of vertical wedges so as to secure them more firmly, and to prevent them from slipping sideways. To effect the latter object, the patentee makes projections in the chair which confine the wedge laterally; and to keep the wedge firmly in its place vertically, he uses a pail that fits into notches cut either into the jaw of the chair or into the wedge

Fig. 1.



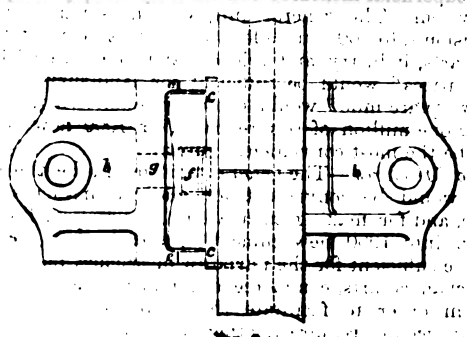
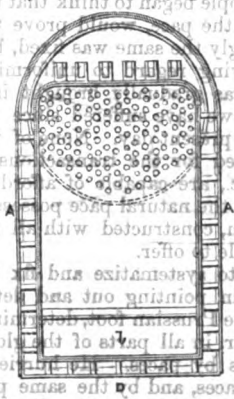


Fig. 2.

itself. Fig. 1 represents a section of a rail, chair, and wedge of this construction; and fig. 2 is a plan of the same. The chair *b*, is so formed as to fit into one side of the double-headed rail; and the other jaw of the chair is nearly perpendicular, with a projecting curved piece to diminish the friction of the wedge *d*. The block *c*, is shaped on one side to fit against the rail, and the other side is notched to catch against the pall *f*, and prevent the wedge from rising out of its place. The plan (fig. 2) shows the projections *e*, *e*, by which the wedge is retained laterally in its position. There are other arrangements for producing the same effects, in one of which the pall is fixed into the jaw of the chair, and acts against notches in the wedge. This is a much better arrangement than the one shown above, because it would diminish the liability of the wedge to become loose by the shrinking of the wood, which appears to be the most objectionable part of this contrivance. It is very questionable, also, whether the curved form given to the jaw of the chair against which the wedge is driven would not be a disadvantage, for instead of diminishing friction, for which purpose that curve is stated to be made, the object should be to increase the adhesion of the wedge to prevent the rail from shaking. When the rail is required to be removed or shifted, it is proposed to withdraw the pin of the pall, and a slot *g*, is made in the side of the chair to admit a lever for raising it from its position.

Tubular Boilers.

A patent has been granted to Robert Robey and George Lamb Scott, of Lincoln, engineers, for "improvements in locomotive and other boilers." These improvements consist in continuing the water space under the fire-box, so that the furnace may be surrounded by water on all sides. The accompanying woodcut represents a section of the boiler with this addition. The letters A, A, show the ordinary water spaces on each side of the fire-box, with their stays; *b*, is an opening into the ash-pit below the fire-bars; and D, is the continuation of the water space below the fire. The object of this arrangement is to make the heat beneath the fire available, in the same manner as in circular boilers with the furnace in the centre. There would be considerable saving of heating power by this contrivance, and if it can be adopted without inconveniently extending the depth of the fire-box, it would be an advantageous addition to tubular boilers.



Furnace Bars.

Mr. John Juckes, who is well known for his smoke-consuming furnace, has obtained a patent for improvements in its arrangement, with the view to overcome a practical difficulty in the working of the endless chain of bars that constitutes the grate of his furnaces. In the construction of furnaces where continuous chains of fire-bars are used, the separate bars have hitherto been so connected together that the chain was necessarily broken when any of the bars had to be removed. The object of the improvements now patented is to attach the short bars in such a manner that any one of them can be removed without breaking the connection of the chain. The inventor describes these improvements to "consist in constructing an endless chain of the desired length of parallel plates, connected together at each end by bolts, and kept separate by washers or projections. In order to attach the fire-bars to this chain, the bars, which are short, have each a descending projection with a hole through it, and there is a hole through each of the plates of which the chain is composed, through which holes in the chain and through holes in each of the projections of the bars, bolts pass which retain the short bars parallel to each other and attach them to the chain, so as to make up a complete endless chain of short bars, and so also that any of the short bars may be removed and replaced without separating the endless chain." The principle of Mr. Juckes's invention, of an endless chain of fire-bars kept in motion, so as gradually to introduce the coal at one end of the furnace, is excellent, and the improvement in the arrangement that renders it more applicable for general use, and removes the inconveniences attending its working, is a valuable improvement in the construction of furnaces.

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ON THE MOST CONVENIENT SYSTEM OF MEASURES AND WEIGHTS, BASED ON THE NATURAL PACE OF MAN.*

By C. A. Henschel, of Cassel, Germany.

Since the nations of the civilised world, urged on by a new state of things, are progressing and mutually competing in arts and sciences, in commerce and industry, and all are beginning to enter into intercourse with each other, it is no longer sufficient that each of these states should have its own peculiar yard or pound, which it may have decreed according to its own convenience. In future, nothing less than a general agreement on one and the same system of weights and measures is likely to meet the wishes of all concerned.

That an agreement of this kind is becoming indispensable in modern times, has been pretty generally conceded, though as yet it has never been taken into serious consideration, owing partly to the obstacles in the way of introducing it being considered insurmountable, partly to a misconception of a measure which nature herself has indicated in the construction of our own body—namely, the pace of man, which is not only necessary to accomplish locomotion, but is also clearly indicated as being the most proper for taking measures. People began to think that the length of the human foot, instead of the pace, would prove the most desirable measure, and accordingly the same was fixed, but differently in each place, without having regard to uniformity; so that a multiplicity of measures was gradually brought into existence, from which state of things we have suffered since the building of the tower of Babel to the present day. None of the measures thus introduced and adopted for the transactions of daily life, such as the yard, cord, &c., are capable of affording that convenience and simplicity which the natural pace possesses, not excepting even the metric system, constructed with all the advantages which science has been able to offer.

In spite of all that has been done to systematize and fix the metre, and the admirable exactitude in pointing out and determining some foot-measures, such as the Prussian foot, determined by Bessel in the year 1816, the soldier, in all parts of the globe, constantly exercises and manœuvres by paces. He hurriedly takes his measure of the ground by paces, and by the same process he, as well as the sportsman, takes his shooting distance. In the same way, geometers take sketches for complicated details; and by exactly the same process, the traveller measures and marks the length of remarkable edifices, places, vessels, &c. Nay, even in common conversation, we are more easily understood if moderate distances are described in paces; and all for the obvious reason that, by means of our daily practice of pacing, the length of the pace is always the most clearly before our mind. But, at the same time, people have unfortunately been guilty of inconsistency in adopting an artificial unit of measurement for other dimensions of one and the same object, particularly the height of houses, towers, masts, trees, mountains and hills; thus the relation between length and height, which is far more important than the absolute size of these dimensions, has been disturbed to such a degree, that the intended clear perceptibility of things cannot be accomplished unless by a tedious reduction of figures. The simultaneous use of two measuring units (not to mention the legion of others) is, therefore, it must be conceded, a great evil, calculated to render most difficult all insight and judgment, whenever such must be taken instanter; and our wishes for a uniform system are silenced by our having become accustomed to believe that it cannot be otherwise. Fortunately, however, the evil alluded to is not a necessary one, for, having created it ourselves, under a false view of things, it will be admitted that we are at liberty to do away with it, after having gained a juster conception of the subject. And we can abolish the evil by adopting a measure of exclusive validity, than which nothing is better adapted to meet the exigency—namely, the pace, owing to its peculiar convenience for the use of man.

The process of measuring will thus be brought to its third and last stage, that of convenience and simplicity; and the only problem yet to be solved will be to qualify the pace of man for an exact measure by properly determining it, as the same has been used since the earliest ages of man for an approximative measure; and finally to construct on that basis a system of weights and measures analogous to the metrical system, which would be most capable and sure of being easily introduced, owing to the metrical system now being pretty generally known.

In order to ascertain the average length of the human pace, the author has counted the paces of many persons, made on a piece of ground which had been previously measured and was clearly perceptible from his room; and as those whose paces he studied were not aware of being observed, their pace was as natural as could be desired. The average of 100 observations gave the result, that the length of the pace is equal to 800 millimetres, with few very slight differences. Further observations were made by some officers, who took an interest in the matter, and noted down the movements of troops on the road. If the regiments of the guards are excluded, owing to the unusual size of the men, the result of the military observations coincides precisely with the measurement of the average pace of civilians, viz. = 800. This average length of pace, so well determined in figures by 0·8 metres, as well as the almost exact harmony of the result of both trials, cannot be considered as being the consequence of a natural relation between metre and pace, but only as a favourable coincidence, which, in this instance, is very welcome, because the introduction of a normal pace-measurement will be greatly facilitated by the aid of the metre. At the same time, all those who consider the metre essential as a constant natural measure, and are wont to regard the number of 40 millions of metres as being the circumference of the globe, will be satisfied when they see that such number can be just as well expressed by 50 millions of paces.

As regards the subdivision of the normal pace, the metre and other decimal measures having preceded, it must be admitted without hesitation, that it will be best to regulate the pace according to the decimal system, excepting, perhaps, those measurements, which in the daily transactions of the retail-trade, at markets, in shops, &c., can be most conveniently arranged by continuously halving measures and weights. In the first place, therefore, the pace is to be divided into ten equal parts, which tenths (being about the breadth of the human foot) we may name "new feet." If a tenth of such "new foot" is named "new inch," a tenth part of a "new inch" being called "new line," a system would be formed, perfectly analogous to the metrical division; to which must be added the convenience that one would be free to choose one or the other of these measures, according to the size of the object to be measured, a convenience proved by experience. Of the multiples of the pace it would only be necessary to take the rod of the land-surveyor at 5 paces, his measuring-chain at 25 paces, and, in general, the "new mile" at 1000 paces (making 125 to the centesimal degree). People will soon get accustomed to the shortness of this "new mile." Up to 1000 paces no subdivisions need be taken, nor from thence up to the greatest length, viz. the circumference of the earth = 50,000 miles. Even in France people are gradually adopting the sole use of the "kilometre," being analogous to the "new mile." With regard to the other mode of subdividing the normal pace by continuous halves, it is only the yard as a measurement of length that deserves our attention. We take the yard to be equal to one pace, dividing the same as stated above into ½, ¼, ⅛, &c., dividing the other side of the measure into 100 equal parts, in order thus to pave the way to the decimal division.

The superficial measures can be very simply adapted to the new system. The general unit, viz. the square pace, with its subdivision into 100 square feet, &c., seems to meet the exigencies of arts, industry, and science; and one acre of 1000 "new square paces" would be sufficient for land-surveying. Hence, a "new square mile" would contain the following, viz.: 1000 × 1000 = one million of square paces, or 1000 new acres, which would be the most convenient figures.

Cubic Measures.—The general unit might be the cubic pace, which would be convenient for all measurements of larger volume, and for making calculations in practical life. Its subdivision into 1000 new cubic feet, and further decimal parts, would be sufficient for the purposes of science, building, mining, the mechanical arts, commerce and industry; and only the retail-trade, in order to facilitate the application in shops and at markets, would require another division of the cubic pace in accordance with the principle of continuous halves, because the term "half" is the most easily understood. In this instance, the different measures of capacity for measuring grain and fluids have principally to be taken into consideration, not only in regard to the correctness of the contents, but also with reference to the convenience of their size and form for daily use.

* Translated from the German: being an abstract from a pamphlet, in which the said system is projected according to, and in connection with, the metric system.

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Weights.—Here we adopt, without further hesitation, the kilogramme, according to the same principle, as laid down above, in ascertaining the measurement of lengths; we take the kilogramme as being equal to 1000 "grammes," as it is used now, and find, that $(1 \text{ m.})^3 (0{\cdot}8 \text{ m.})^3$ the weight of a "new cubic foot" of water, equals 1000 "grammes" $\times (0{\cdot}8 \text{ m.})^3 = 512$ grammes, which we may very properly call "new pound" ("livre"); the more so, as it agrees with the old pound usual everywhere, as nearly as can be desired in the absence of a natural relation between metre and pace.

As regards naming the subdivisions of measures and weights, it would certainly facilitate their use, if these also could be uniform among all nations, but the difficulty which the introduction of the metrical system has met with in France, compared with the much easier introduction of this system in Holland, would seem sufficiently to prove that it would be well to take the special nomenclature as much as possible from the languages themselves. In the outset, it is of paramount importance to keep intact this system, based on the innate force of simplicity and convenience, whilst the linguistical part of it may properly be left to future development, till a period when the general union of languages will have made its progress—by railroad.

It is, however absolutely necessary that all old and contradictory customs in reference to sizes, division of measures and weights, be entirely done away with, as otherwise neither a general agreement on these things, nor the immeasurable advantages accruing therefrom, can be thought of. Accordingly in France, as early as 1789, a desire for equal measures and weights began to show itself, and in 1790 it was determined that the Royal Society of London and the Paris Academy of Sciences, joined with learned men of all civilised countries, should be induced to prepare a new system of measures and weights. But the events of that time were not favourable to the execution of a plan of such magnitude. It was thought sufficient to entrust it to a committee of the most celebrated French mathematicians and physicians, but unfortunately without considering the necessity of likewise joining to such a committe proper commercial and industrial capacities, to represent the special interest of these branches, which so immediately form the corner-stone of the material well-being of nations. The measuring of degrees, interesting as it is in a scientific point of view, with which the work was commenced, would then probably not have taken place, or a least a use would have been made of it, which had the convenience of the common measuring more in view, and the metre would not have received its present unpractical length. This defect in the metre can only be done away with by changing it into a shorter measuring unit.

In Germany, where the evil of complicated measures and weights has been greatest from times immemorial, several governments have made attempts to unravel and unite the systems, but thus far without any complete success, because, despairing in the outset of the possibility of a thorough reform being consistently carried out, people were disposed to rest satisfied with partial successes. But this will not do with measures and weights. Everything that is done in this matter must bear a character of perfection as far as it is possible, because every change that became necessary hereafter would require new ones, and thus again tend to complicate the whole.

Whilst the same objections are applicable to all artificial measures, as has been proved above, and none can be recommended for general use, the exclusive application of the measure of paces will serve infinitely to facilitate all kinds of measuring. All civilised nations concur in the opinion, that the time has arrrived when something decisive must be accomplished, and is is only to be apprehended that the impatient nations, who naturally wish soon to partake of the thing desired, might again resort to partial improvements, and thus again further remove the object of their wishes. Finally, however, though perhaps only after repeated failures, it will have to be admitted that a step backwards, to the sole use of the natural and inevitable measure which the pace suggests, will be the only means to relieve us from the obscurity of complicated measures, with their laborious reductions, mistakes, and loss of time; whilst, on the other hand, it need not be apprehended that the measure of the pace, reinstated in its old rights, will ever again be superseded by a more convenient measure.

THE PRODUCT OF IRON.

A very interesting paper has recently been read by Mr. Abram S. Hewitt, on this subject, before several scientific associations in the United States, displaying much skill in composition and intimate knowledge of the subject discussed.

He speaks of Neilson's invention of the hot blast in 1830, having had a marked effect upon production, as the following table will show: In England,

In 1836 the make amounted to	1,000,000	tons.
In 1839 " " " "	1,248,781	"
In 1840 " " " "	1,396,400	"
In 1845 " " " "	1,512,500	"
In 1847 " " " "	1,969,607	"
In 1852 " " " "	2,701,000	"
In 1854 " " " "	3,585,906	"

"This was made," says Mr. Hewitt, "by 599 furnaces, giving an average to each of 6000, being 2½ times the yield of each furnace in 1825. This incredible product was achieved by the direct labour of 238,000 men and 2120 steam-engines, as an aggregate power of 242,000 horses, and the value of the gross product was $125,000,000." To make this gross product and reduce rather more than half of it to bars, there were dug from the bowels of the earth and consumed:

Iron ore	21,346,000 tons.
Limestone	2,458,000 tons.
Coal	20,942,000 tons.
Total	44,746,000 tons.

A sum total before which, as Mr. Hewitt very properly observes, "the imagination stands appalled."

But even these figures seem trivial when we come to estimate the demand for iron in the future. The present annual production of the world does not exceed 7,000,000 tons, of which Great Britain produces rather more than one-half. Assuming the population of the world to be 900,000,000, the production and of course the consumption is at the rate of 17 lb. per head. Supposing the population of the world to be doubled in 100 years, the consumption in 1956 will be 200,000,000 tons per annum. From 1840 to 1855, the production increased 70 fold. At the same rate of increase, the annual make would reach in 115 years 490,000,000 tons. From 1806 to 1824 the production of Great Britain was doubled. In 1836 it had again doubled, requiring a period of six years less than the former period. In 1855, a period of eight years, it had risen from 2,000,000 to 3.500,000 tons, at which rate it would double in ten years. Mr. Hewitt supposes the production of the world to double once in twenty years, and gives us the following enormous figures:

In 1875 the production would be	14,000,000	tons.
In 1895 " " " "	28,000,000	"
In 1915 " " " "	48,000,000	"
In 1935 " " " "	96,000,000	"
In 1955 " " " "	192,000,000	"

This seems a wild calculation; yet Mr. Hewitt shows that the world will have a use even for this astonishing quantity. The demands for railroads alone he estimates as follows:

"In Great Britain there is one mile of railroad to about eight square miles of surface. In Connecticut the ratio is about one to six. In New York the ratio is about one to twenty. The habitable world would not be over supplied with the conveniences for travel and transport if one mile of railroad were built for each ten square miles of surface.—Now, according to the best authorities, there are 20,000,000 square miles of habitable surface on the globe, which will ultimately require 2,000,000 miles of railroad. To lay and operate this quantity will require 600,000,000 tons of iron, the annual wear and operation of which will demand at least 60,000,000 per annum. The consumption for railroads now absorbs about one-third the make of iron; and it is apparent that while the use of iron for the purposes for which it has been long applied is daily growing, each year brings forward new applications which seem to indicate that there is no practical limit to its use."

The next question that arises is—"How and where, geographically considered, is this enormous quantity, or the half of it, or the quarter of it, to be made?" This brings Mr. Hewitt to consider "the elementary conditions essential to a large production of iron." These are—

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1st. An adequate supply of the requisite raw materials, ore, limestone, and mineral coal; for charcoal can only be used, as we have seen, to an insignificant extent.

2nd. Those raw materials must be geographically so situated as to be brought cheaply together; for the value of raw materials does not more consist in what it is, than in where it is, a fact too much overlooked in the mining projects of the present day.

3rd. There must be cheap means of transport to market.

4th. There must be sufficient density of population to insure labour at moderate cost.

5th. There must be adequate capital to build and carry on the works.

6th. There must be skill to manage them in the most economical manner.

7th. There must be indomitable energy and strict integrity in management; that is to say, the iron business can only exist on a large scale where the people are essentially industrious, intelligent, energetic, and honest.

All these elementary conditions, Mr. Hewitt thinks, are combined in Great Britain to a remarkable degree. But he believes that there is a natural limit beyond which an adequate supply of raw materials cannot be procured. Nor will the advantages which England possesses in the way of capital last for ever. A point will be reached which will over-task her natural resources, in the way of raw materials and labour, and when it will cost her more to make iron than it now does. Is she approaching, or has she reached the limit "when the demand will be large enough permanently to raise the price, so as to permit other countries to engage in the business, without the aid of artificial stimulants to production?" "I do not wish to be understood as saying, that even with the present demand Great Britain cannot undersell the world. Far from it; she can do so. But I do wish to say, that if the addition of a million of tons to the demand has doubled the prices, the addition of another million to the demand would have a decided influence in still further advancing them, and that at length, in the progress of the world, a point would be reached beyond which the required iron could not be supplied at all." From what quarter of the globe is the deficiency to be supplied?

Mr. Hewitt very decidedly responds to this query,—from the United States. We have not space in which to state his reasoning, but we give his practical conclusions. They are as follows:

1. The United States have greater natural resources for the production of iron, than any other country of the earth, in consequence of the moral elements which characterise the nation, the unlimited possession of mineral coal, the abundance and richness of its ores, and the vast system of natural and artificial avenues of transportation which traverse the land.

2. The difficulties in the way of a large production are purely social and artificial, viz.: The dearness of capital and labour, which obstacles are being surely and slowly overcome by the progress of the country and the fact that the increase of consumption throughout the world will at an early day task the production of iron in Great Britain to its utmost limits, and consequently increase its cost and price.

3. That as the United States have no competitor but Great Britain, the surplus demand, over and above the power of Great Britain to supply, must be met by the United States; and that it would, therefore, be unwise for the national government, in order to benefit any particular interest, to adopt such legislation as would discriminate against the iron business, inasmuch as it would only retard progress that is inevitable, by bringing ruin upon those who have been pioneers in establishing a great branch of industry, especially as it is now proven that American rails can be made at the average cost of foreign rails.

4. That the growth of the business hitherto has surpassed the corresponding growth in Great Britain, and as we may be said to have commenced fifty years behind her, we are at this day only nineteen years in arrear, and may, under all the circumstances, reasonably expect to overtake and pass that country in the amount of annual production.

5. That owing to the superior richness of our ores it is probable that science will enable us to dispense with some of the intermediate processes now necessary for the production of wrought-iron, and thus achieve an inequality, in point of cost, with Great Britain, even before the inequality in cost of labour and capital is reached.

THE NEW READING ROOM AT THE BRITISH MUSEUM.

It so seldom happens that the *Times* comes out with a leader upon architectural subjects, that when it does so, we are bound to treat it as a *rara avis*, and in this case cannot refrain from giving the article *in extenso*, with a sincere hope that what influence our columns may possess, as a journal devoted to the subject, may result in inducing the trustees to take immediate steps to fulfil the writer's advice, who—there is but little doubt—speaks the opinion of the majority of a people who never begrudge a few thousands for a national object; and we feel certain, from the knowledge we have of Mr. Sidney Smirke, that he, as the architect, never can sanction the miserable paucity of ornament now contemplated in decorating one of the finest domes in the world:—

"London is a colourless metropolis. It is like a landscape in sepia, without the finish of a line engraving or the gloss of a pencil drawing. Everything matches; the houses are black, or whity-brown: the streets dirty, the sky semi-opaque, and the clothing of the passengers dark or dusky. The very women contribute little relief to the eye, from the English habit of wearing patterns, and a multitude of tints, rather than one or two contrasted colours. As to the buildings, here and there you have a few bits of red brick, but you may count them off on your fingers. There is the new church in Margaret-street, and the piers of Hungerford-bridge, and Billingsgate-market, and a Saracenic school in Endell-street, St. Giles's, and another building of the same character near Covent-garden, and a few more. Then you have the granite columns of the Carlton, and some granite panels at Mr. Hope's, in Piccadilly. But the general hue of things in this metropolis is that which the ancient poets assigned to Hades, and which produced so dreary an impression on its occupants. As for internal decoration, the Houses of Parliament are gorgeous enough, and the merchants in the Royal Exchange have some pretty ornaments in colour over their heads, if they have time to think of other things than business between three and four. Then, the interior of the Coal-Exchange is a very gay affair, considering the character of the traffic. So, also, is the interior of the Temple church. But, with these and a few other such exceptions, we are so sombre that we have little reason to talk of the drab-coloured Pennsylvanians. We have no doubt that Philadelphia, with all its straight lines and its numbered streets and avenues, is a brighter city than London. The excuse is the monstrous cloud of smoke we are always blowing, and with which we stain earth, river, and sky. We must have a stone-colour or some shade of white, because as soon as it shows the dirt it can be painted again; and, even if it be dirty, it at least husbands the little light than finds its way into our streets and public buildings. In the foreign capitals the stone has a natural colour; the lichen has a natural colour; and the weather-stains have something of nature about them. The three primitive colours, too, are displayed without reserve in their original purity, not only in the dresses of common people, and even in their umbrellas, but also on the window shutters and other woodwork of the houses. But it is when you enter any church or public building that you find yourself in a region of colours. Walls, roof, and the very floor glow with decoration. Much of it is dusty enough, and smoky enough; but rich colours show through the dirt. Anybody with the least knowledge of either classic or mediæval architecture knows it to be as incomplete without colour and decoration as the 'human form divine' or the face of nature. The modern idea of white-washing or stone-washing everything inside and out is architectural quakerism, with nothing to recommend it, excepting that if you are bound by the terms of your lease to paint and wash once in four years, stone colour is the cheapest way of fulfilling the obligation.

"Just now, if the opportunity be not past while we are writing, we have one of the grandest opportunities of 'decoration' likely to occur for we know not how many years. While the attention of the public has been concentrated on the Crimea, and only diverted by a few noisy trifles at home, there has been rising up in a place where nobody can see it one of the finest rooms and unquestionably the very best dome in the world. The new reading-room of the British Museum, ingeniously constructed in the quadrangle of that building, and surrounded by magnificent corridors, is surmounted by a dome the internal diameter of which is only 2 feet less than that of the Pantheon. The interior

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of the dome of St. Paul's is about 100 feet; that of St. Peter's under 140; that of the Pantheon 144; and that of the new reading-room 142. We believe the elevation is greater than that of the Pantheon, the lighting better, the design far more graceful, and the construction infinitely more scientific. The reader henceforth, instead of being packed with two or three hundred other people in a close, dusty apartment, without elbow-room, with a scanty supply of light only on one side, and with readers and attendants moving to and fro just before his eyes, will be seated at a desk of his own, as wide as any gentlemen can desire in his own library,—4 ft. 6 in., we believe, with a screen before his eyes, and a table at hand for the display of the largest maps or books of reference. His light will be from a lofty dome, surrounded by windows, and surmounted by a large circular light. The room will be surrounded by shelves, rising to a considerable height, and capable of holding, we believe, 35,000 volumes, likely to be most in demand, which will be reached by light iron galleries, of such a design as not to obstruct the light from a single book, or interfere with the general effect, at the same time that they bring every volume within reach of the librarians. This room will open all round into a circular corridor of great height, furnished in like manner, and of immense capacity, the shelves rising some 30 feet or so above the floor of the reading-room and 10 feet below. Other galleries of great length, rooms of great capacity, and arrangements marking the utmost care for the wants, not only of the general class of readers, but of the most distinguished student, complete the plan of a vast edifice, which, after all, does not take away any perceptible quantity from the light of the rooms in the original structure. It has been computed that, even at the present rapid rate of increase, there is now space for books for three generations. We can answer for it, from our own inspection, that it will certainly take that time before the shelves for the London newspapers are all occupied. The whole substructure under the flooring of the dome is one vast hypocaust, or reservoir of warm air, while the space between the inner ceiling and outer brickwork of the dome is full of flues to carry the warm air out at the circular louvre; and so ample is the space that in the coldest day, if the room by fires overnight is properly warmed in the morning, there will be sufficient supply of warm air till the evening without either a decrease of temperature or a feeling of closeness.

"But it is with the proper decoration of this room that we are now concerned. There can be no doubt that, had such a room been built either in classic or in mediæval times, it would have been lavishly adorned with bronzes and gilding, with marbles and mosaics. It would have been made one vast receptacle of ornament. No doubt, too, if such a building were raised in any other European capital than our own, there would not be a square inch left without gold or colour. Yet, for the paltry saving of five or six thousand pounds, the probable cost of a sufficiently effective decoration, the interior of this unequalled dome is to be left as colourless as the rotunda of the Bank. At least, all that is to be attempted is to distinguish the panels with a faint shade of blue, and the mouldings with a faint shade of another colour. From the specimens cleared for view, nothing can be more shadowy and cheerless. Yet the design of the ceiling, the plainness of the panels, and the shallowness of the mouldings, are all adapted for decoration,—that is, they would give effect to colour, and without colour be themselves ineffective. But the expense is as nothing compared with the character of a building, as the great hall of British literature and the resort of scholars from all nations. It is, too, as nothing compared with the whole cost of the building. The reading-room, with its corridors, galleries, and other rooms, will cost 120,000*l.*, and nobody who has seen it will think the money ill-spent. Five thousand pounds is little more than 4 per cent. on the gross expenditure, and for this paltry saving it is now intended to leave this otherwise magnificent interior in a state that will make it rather a disgrace than a credit to our country. Nor is it clear that economy is not on the side of decoration of the most gorgeous kind. Gilt stands for ages, and any colour stands better than white. Dust and stains show upon a whitish ground, whereas they deduct little from the general effect of a rich decoration. Now, however, is the time to decide. The dome is ready for the house-painter, or the decorator, as the case may be; in a few weeks the 4000 poles of which the immense scaffold is composed will be cleared away, and it may be fifty years, or more, before they are raised again. When one considers how many a 5000*l.* is muddled or thrown away, and nobody the better for it, it does seem a very paltry saving to mark the difference between a glorious national ornament—a sight to gladden the eyes and for an Englishman to be proud of—and a huge vault that nobody will care to look twice at, except as a proof of our national imbecility and poverty of spirit. Nothing, indeed, is more disgraceful than to have a good opportunity and not to use it."

ON THE ACTION OF RIVERS ON THEIR BEDS.

By Joshua Wilson, Sunderland.

The agencies by which a river forms and maintains its channel are of two descriptions, which I shall designate its abrasive and impinging forces.

The impinging or excavating power is produced when the set of the stream forms an angle with the bottom or sides of the channel, by which action its banks are hollowed, or pools formed in its bed. The effect of this impact is to deflect the current, and thereby to create an eddy in which the excavated material finds a resting-place; producing irregularities in the channel as a natural result. This tendency is kept in check by the abrasive action of the stream, which, being the resultant of the friction of the current, when its set is parallel to the river bed, the transporting power of the latter is more dependant on its volume or depth than on its velocity. From the circumstance that the velocity of a stream is dependent (*ceteris paribus*) on the slope of its surface, we must necessarily admit that an increase of the impinging action will accompany an augmentation of its velocity.

A river whose current moves at the rate of two miles an hour, must necessarily require twice the sectional area of channel that one does with a velocity of four miles, for the discharge of a similar quantity of water.

A stream meets with the least resistance to its progress when it passes through a lake, in which case the slope of its surface, as well as its velocity, are reduced to a minimum; but from the absence of any scouring action on the bed of the lake, a constant deposit will take place thereon. When the stream is in its ordinary state, a similar deposit takes place in the pools formed in the beds of rivers by the action of land-floods; but, on the recurrence of a flood, not only are the lighter deposits swept away by the abrasive action of the stream, but rough gravel is frequently carried along these deeper portions of the channel, to find a resting-place on the shallows, where it resists the impinging action generated by the increased velocity of the stream over these declivities.

A river will maintain its channel with the minimum velocity, and maximum sectional area, when its breadth is great in proportion to its depth; any increased declivity of its bed will augment the impinging action of the stream, which action, by producing irregularities in its channel, will reduce the sectional area to the size merely adequate for the passage of the more rapid stream.

A contraction of the width of the stream will augment its velocity, and with that the abrasive or frictional action on its bed, thereby adding to its depth; but, as the increased scouring power thus expended has its origin in the velocity of the current, its existence is dependent on the reduced sectional area of channel which produces that velocity. A rapid shallow stream, flowing over a rough gravelly bed, exhibits an uneven surface from the irregularities in its bed giving an upward movement to the water in passing over them. An increase in depth will impede this action, thereby augmenting the friction and with it the transporting power of the stream. This will satisfactorily account for the disappearance of gravel from the lower reaches of rivers, where a small inclination of surface is associated with an increased depth.

In tidal rivers it is clear that a large sectional area of channel is rather due to the scour of the greater volume of the early ebb, than to the comparative small and usually rapid current of the last quarter; hence the great injury to navigation that invariably follows the enclosure of lateral indents and salt marshes, which, although they may only be covered on spring tides, are of essential importance for the maintenance of a good channel, from the circumstance of their yielding up their water during the early ebb when the scouring power is at its maximum. Although a deep narrow channel may be the form best adapted for the purpose of navigation, a broad shallow expanse is a superior one as a tidal receptacle.

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ON FIRES, AND FIRE-PROOF STRUCTURES.

By JAMES BRAIDWOOD, Assoc. Inst. C.E., Superintendent of the London Fire Brigade.

[*Paper read before the Society of Arts, London, May 7th.*]

I HAVE been requested by the Council of the Society of Arts to send them some information as to "Fires: the best means of preventing and arresting them; with a few words on fireproof structures." It is with great diffidence that I attempt a subject of such importance to the community, not only from my inability to do it justice in writing, but from the excessive difficulty of making each person comprehend the necessity of being sufficiently careful, due care being the best prevention against fire, as well as against many other evils.

To prevent fires it is necessary to consider what are the principal causes of such calamities. These may be classed under several heads:—

1. Inattention in use of fires and lights.
2. Improper construction of buildings, &c.
3. Furnaces or close fires for heating buildings, or for mechanical purposes.
4. Spontaneous ignition.
5. Incendiarism.

There is little to be said on the first head, which is not well known to most masters of houses or other establishments, but the difficulty is, to keep up their attention, or that of those under them. Some years ago, upwards of 100,000*l.* were lost, through the partner of a large concern lighting gas with a piece of paper, which he threw away, and thus set fire to the premises, although it was a strict rule in the place that gas should only be lighted with tapers, which were provided for that purpose. In one department of a great public institution it was, and is still, a rule that only covered lights should be carried about, and for that purpose four lanterns were provided; yet, on inquiry some time back, it was found that only one was entire, the other three being broken—one having lost two sides and the top; still they were all used as covered lights.

The opportunities for inattention to fires and lights are so various that it is impossible to notice the whole. Incautiously approaching window and bed curtains with a light, and airing linen before the fire, are almost daily causes of fire in London, and some of the most distressing cases of loss of life have originated from these and similar causes. Children playing with fire is also another constant cause of fire, and frequent loss of life. The dresses of females taking fire adds very much to the list of lives lost by fire, if it does not exceed all the other causes put together. Taking off the burning coals from a fire, and laying them on the hearth, also causes fires occasionally. Reading in bed by candle-light is another source of the same evil. A very serious annual loss is also caused by want of due care in hanging up or removing the goods in linen-drapers' shop-windows when the gas is burning. Flues taking fire often result in mischief, and it is believed that many serious fires have arisen from this cause which can hardly be called accidental, as if flues are properly constructed, kept moderately clean, and fairly used, they cannot take fire.

From what has been said, it will be seen that care and attention may do a very great deal towards the prevention of fire, and consequent loss of life. It is very easy to make good rules, and keep them for a time, after having been alarmed by some serious loss of property or life, but the difficulty is to maintain constant attention to the subject. The most evident plan for effecting this seems to be, for the masters thoroughly to examine and consider the subject at certain stated periods, not too far apart, and to constantly warn their domestics, workmen, or others, of the danger of the improper use of fire and lights.

One of the greatest preventives of carelessness in the use of fires and lights would be a legal inquiry in every case, as it would not only show the faults that had been committed, and thus warn others, but the idea of being exposed in the newspapers would be another motive for increased care. This plan has been adopted in New York, and the reports of the proceedings of Mr. Baker, the "Fire-Marshal," show that the inquiries there made had met with most useful results. Mr. Payne, the coroner, held inquests on fires in the City some years ago, but the authorities would not allow his expenses, and, therefore, they were given up, although believed to be highly advantageous in explaining accidental and other causes of fire.

The improper construction of buildings more generally assists the spread than is the original cause of fires; although laying hearths on timber, and placing timber too near flues, are constant causes of fire, and it is believed that many melancholy occurrences have arisen from these and similar sources. It is true the Building Act forbids all such proceedings, but the district surveyors do not seem to have sufficient power, or be able to pay sufficient attention to such matters, as they are constantly met with at fires. A very flagrant case of laying a hearth on timber was lately exposed by a fire in the City. Due notice was given of the circumstance, but no further attention was paid to the matter than to make the proprietor construct the floor properly, although the Act gave power to fine for such neglect. This omission is to be regretted, as there could not have been a better case for warning others; it occurred in a very large establishment, and the work was done by one of the first builders in the City. Had this fire taken place in the night, and gained some head, it would have been very difficult to have ascertained the cause. As the premises were situated a serious loss of life might have occurred, the apartment in which the fire originated being the only means of retreat which ten or twelve female servants had from their bed-rooms.

The Building Acts, up to about the year 1825, by insisting upon party walls and other precautions, were invaluable for the prevention of the spread of fires. By them no warehouse was permitted to exceed a certain area. From the year 1842, the area has been exchanged for a specified number of cubic feet. But since 1825, a class of buildings has arisen of which there are now considerable numbers in the City, called Manchester or piece-goods warehouses, which somehow, up to the 1st of January last, have been exempted from the law restricting the extent of warehouses, on the plea that they are *not* warehouses, because "bulk is broken" in them, although it is thoroughly understood that the legislature intended by the Act to restrict the amassing such a quantity of goods under one roof as would be dangerous to the neighbourhood.

It is necessary to state here, that the intensity of a fire, and the risk of its extending to other buildings, depends, *cæteris paribus*, on the cubic contents of the building which takes fire. Manchester and piece-goods warehouses have for some time past been built of unlimited size, sometimes equal to twenty average houses. This is pretty nearly the same as if that number of houses were built without party walls, only that it is much worse, for the whole mass generally communicates by well-holes and open staircases, and thus takes fire with great rapidity, and, from the quantity of fresh air within the building, the fire makes much greater progress before it is discovered. By this means the risk of fire in the City has been greatly increased, not only to such warehouses themselves, but to the surrounding neighbourhood, for it is impossible to say how far fires of such magnitude may extend their ravages under untoward circumstances, there being at present no preventive power in London capable of controlling them. To provide such a power would be a very costly business.

Such buildings are also against the generally received rule, that a man may burn himself and his own property, but he shall not unduly risk the lives and property of his neighbours.

The Building Act, which became law on the 1st January last, is likely to repress, to a certain extent, this great evil, unless its meaning be subverted by some such subterfuge as destroyed the efficiency of the last one. But what is to be done with those which are already built? It may seem tedious to dwell so much on this subject, but it appears to be a risk which is not generally much thought of, though it is of the most vital importance to the safety of London. It is very desirable that the metropolis should take warning by the experience of Liverpool, without going through the fiery ordeal which the latter city did.

From 1838 to 1843, 776,762*l.* were lost in Liverpool by fire, almost entirely in the warehouse risks. The consequence was, that the mercantile rates of insurance gradually rose from about 8*s.* per cent. to 30*s.*, 40*s.*, and, it is said, in some cases, to 45*s.* per cent. Such premiums could not be paid on wholesale transactions, therefore, the Liverpool people themselves obtained an Act of Parliament, 6 and 7 Vic., cap. 109, by which the size and height of warehouses were restricted, party-walls were made imperative, and warehouses were not allowed to be erected within 36 feet of any other warehouse, unless the whole of the doors and window shutters were made of *wrought iron*, with many similar restrictions. This Act applied to warehouses already built as

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well as those to be built, and any tenant was at liberty, after notice to his landlord, to alter his warehouse according to the Act, and to stop his rent till the expense was paid. Another Act, 6 and 7 Vic., cap. 75, was also obtained, for bringing water into Liverpool for the purpose of extinguishing fires and watering the streets only. It is supposed that the works directed, or permitted by these two Acts, cost the people of Liverpool from 200,000*l.* to 300,000*l.* Shortly after these alterations had been made, the mercantile premiums again fell to about 8*s.* per cent.

There is another very common cause of fire, which seems to come under the head of construction, viz., covering up a fireplace when not in use with wood or paper and canvas, &c. The soot falls into the fireplace, either from the flue itself, or from an adjoining one which communicates with it. A neighbouring chimney takes fire; a spark falls down the blocked up flue, sets fire to the soot in the fireplace, which smoulders till the covering is burned through, and thus sets fire to the premises.

The danger from furnaces or close fires, whether for heating, cooking, or manufacturing purposes, is very great, and no flue should be permitted to be so used, unless it is prepared for the purpose. The reason is, that in a close fire the whole of the draught must pass through the fire. It thus becomes so heated that, unless the flue is properly built, it is dangerous throughout its whole course. In one instance of a heating furnace, the heat in the flue was found to be 300°, at a distance of from 40 to 50 feet from the fire. In open fireplaces the quantity of cold air carried up with the draught keeps the flue at a moderate heat, from the fire upwards, and unless the flue is allowed to become foul, and take fire, this is the safest possible mode of heating.

Heating by hot air, steam, and hot water are objectionable. First, because there must be a furnace and furnace-flue, and the flue used is generally that built for an open fire only. And second, the pipes are carried in every direction, to be as much out of sight as possible. By this means they are constantly liable to produce spontaneous ignition, for there appears to be some chemical action between heated iron and timber, by which fire is generated at a much lower temperature than is necessary to ignite timber under ordinary circumstances. No satisfactory explanation of this fact has yet been given, but there is abundant proof that such is the case. In heating by hot water-pipes, those hermetically sealed are by far the most dangerous, as the strength of the pipes to resist the pressure, is the only limit of the heat to which the water and of course the pipes may be raised. In some cases a plug of metal which fuses at 400° is put into the pipes, but the heat to which the plug is exposed will depend very much on where it is placed, as, however great may be the heat of the exit pipe, the return pipe is comparatively cool. But even where the pipes are left open, the heat of the water at the furnace is not necessarily 212°. It is almost needless to say that 212° is the heat of boiling water, under the pressure of one atmosphere only; but if the pipes are carried 60 or 70 feet high, the water in the furnace must be under the pressure of nearer three atmospheres than one, and, therefore, the heat will be proportionately increased. Fires from pipes for heating by hot water have been known to take place within twenty-four hours after first heating, and some after ten years of apparent safety.

The new Building Act prescribes rules for the placing steam, hot air, and hot water pipes at a certain distance from timber, but as it must be extremely difficult for the district surveyors to watch such minute proceedings, it becomes every one who is anxious for safety, to see that the district surveyors have due notice of any operation of this kind.

Another cause of fire which may come under this head is, the use of pipes for conveying away the products of combustion. Every one is acquainted with the danger of stove pipes, but all are not perhaps aware that pipes for conveying away the heat and effluvia from gas burners, are also very dangerous, when placed near timber. It is not an uncommon practice to convey such pipes between the ceiling and the flooring of the floor above. This is highly dangerous. Gas burners are also dangerous when placed near a ceiling. A remarkable instance of this took place lately, where a gas-burner set fire to a ceiling 28½ inches from it.

Another evil of furnaces is, that the original fireplace is sometimes not large enough to contain the apparatus, and the party-wall is cut into. A most melancholy loss of life took place from this cause last winter. Perhaps it may be necessary to notice at this point the use of gas, as it is becoming so very general. Gas, if carefully laid on and properly used, is safer than any other light, so far as actually setting fire to anything goes, but the greater heat given out so dries up any combustibles within its reach, that it prepares them for burning, and when a fire does take place the destruction is much more rapid than in a building lighted by other means. Gas-stoves, also, from the great heat given out, sometimes cause serious accidents; in one instance, a gas-stove set fire to a beam through a 2½-inch York landing, well bedded in mortar, although the lights were 5 or 6 inches above the stone. This is mentioned to show that gas-stoves require quite as much care as common fires. The heat given out by the gas also increases very much the risk of spontaneous ignition. This is believed to be a very fruitful cause of fires; but, unless the fire is discovered almost at the commencement, it is difficult to ascertain positively that spontaneous ignition has been the cause. Spontaneous ignition is generally accelerated by natural or artificial heat. For instance, where substances liable to spontaneous ignition are exposed to the heat of the sun, to furnace-flues, heated pipes, or are placed over apartments lighted by gas, the process of ignition proceeds much more rapidly than when in a cooler atmosphere. Sawdust in contact with vegetable oil is very likely to take fire. Cotton, cotton waste, hemp, and most other vegetable substances are alike dangerous. In one case oil and sawdust took fire within sixteen hours; in others, the same materials have lain for years, until some external heat has been applied to them. The greater number of the serious fires which have taken place in railroad stations in and near London, have commenced in the paint stores. In a very large fire in an oil warehouse, a quantity of oil was spilt the day before and wiped up, the wipings being thrown aside. This was believed to have been the cause of the fire, but direct proof could not be obtained. Dust bins also very often cause serious accidents. In one instance, 30,000*l.* to 40,000*l.* were lost, apparently from hot ashes being thrown into a dust bin.

These accidents may in a great measure be avoided by constant care and attention to cleanliness, and where paints and oils are necessary, by keeping them in some place outside the principal buildings. Dust bins should as much as possible be placed in the open air, and where that cannot be done, they should be emptied once a day. No collection of rubbish or lumber of any sort should be allowed to be made in any building of value.

Mr. Wyatt Papworth, architect, has published some very interesting notes on spontaneous ignition, giving several well-authenticated instances.*

Incendiarism may be divided into three sorts—malicious, fraudulent, and monamaniac. Of the former there has been very little in London for many years. The second, however, is rather prevalent. The insurance offices, which are the victims, protect themselves as well as they can, but an inquest on each fire is the true mode of lessening the evil. This is much more the interest of the public than at first seems to be the case. In several instances where the criminals were brought to punishment by Mr. Payne's inquests, people were asleep in the upper parts of the houses set fire to, and in one case there were as many as 12 or 15 persons. This, however, is seldom stated in the indictment, as if it is, the punishment is still death by the law, and it is supposed that a conviction is more easily obtained by the capital charge being waived. Monomania is a rare cause of incendiarism, but still several well certified cases have occurred in which no possible motive could be given. In one instance, a youth of fifteen set fire to his father's premises seven times within a few hours. In another, a young female on a visit, set fire to her friend's furniture, &c., ten or eleven times in the course of one or two days. In neither case could anything like disagreement or harshness be elicited, but the reverse. In other instances it has been strongly suspected that this disease was the cause of repeated fires, but there was no positive proof. In all these cases, known or suspected, the parties were generally from 14 to 20 years of age.

The best means of arresting fires is a very wide question, as the only limit to the means is the expense. Different nations have different ways of doing the same thing. On the continent generally, the whole is managed by government, and the firemen are placed under martial law, the inhabitants being compelled to work the engines. In London, the principal means of arresting fires is a voluntary association of the insurance companies, without legal authority of any sort, the legal protection by parish engines being, with a few praiseworthy exceptions, a dead letter.

* C. and E. Layton, 150, Fleet-street.

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In Liverpool, Manchester, and other cities, the extinction of fires by the pressure of water only, without the use of fire-engines, is very much practised. The advantages of this system are very great; but, to enable us to follow this system, the whole water supply of London would require to be remodelled.

In America, the firemen are generally volunteers, enrolled by the local governments. They are exempt from other duties, or are entitled to privileges, which appears to satisfy them, as the situation of fireman is eagerly sought in most of the American cities.

Which is the best of these different modes it is difficult to say; perhaps each is best suited for the place where it exists.

On the first discovery of a fire, it is of the utmost consequence to shut, and keep shut, all doors, windows, or other openings. It may often be observed, after a house has been on fire, that one floor is comparatively untouched, while those above and below are nearly burned out. This arises from the doors on that particular floor having been shut, and the draught directed elsewhere. If the fire appears at all serious, and there are fire-engines at a reasonable distance, it is best to await their arrival, as many buildings have been lost from opening the doors, and attempting to extinguish fires with inadequate means. If no engines are within reach, it is well to keep a hand-pump. If that is not to be had, the next best thing is to collect as many buckets outside the room on fire as can be obtained, keeping the door shut; then creep into the room on the hands and knees (if the heat and smoke are considerable), and throw the water as nearly in the direction of the fire as possible, keeping the door shut while more water is being collected. The police of the metropolis understand shutting up fires so well, that they have in many instances kept fires two or three miles distant from the engine stations shut up till the firemen arrived in time to extinguish them.

The description of fire-engines found to answer best in the metropolis are those with 7-inch barrels and 8-inch stroke, throwing, at the ordinary rate of working, about 90 gallons of water per minute. If a larger engine is thought desirable, two of these can be easily joined together in one stream, giving 180 gallons per minute. This size is preferred, because the weight, with hose, implements, firemen, and driver is about 30 cwt., which is as much as two fast horses can manage for a distance under six miles. It is not often that the engines are required to travel further than this; when they are, four horses are used.

For some years past, a hand-pump has been carried with each engine. They have been found of the greatest service in keeping doors, windows, &c., cool. They throw from 6 to 8 gallons per minute, to a height of from 30 to 40 feet, and can be used in any position. The idea of the hand-pumps was taken from the old-fashioned squirt, or "hand-engine."

The committee for managing the London fire-engine establishment have lately turned their attention to steam-floating fire-engines. The first trial was to alter one of the floats previously worked by manual labour. This was found to answer so well, giving 700 gallons of water per minute (ordinary rate of working), under a pressure of 70 or 80 lb. on the square inch, that another was constructed capable of throwing 1400 gallons per minute, and of moving at the rate of 8 miles per hour, propelled by the reaction of two jets of 10-inch diameter each, driven by one of Mr. Appold's pumps.

The firemen are drilled first daily, and then two or three times a week, for some months; and this, with an average of three calls a day, soon makes them acquainted with the routine of their business; but it takes years of constant work to make a thoroughly good fireman.

The main rule to be observed is to get as near the fire, with the branch* inside the building, as possible, so that *the water may strike the burning materials*. If this cannot be done, the probability is that the building which takes fire will be lost. This is not so dangerous an operation as it appears (unless the building is supported on cast-iron, of which more hereafter), as, if the building is of the ordinary strength, the fire requires to burn some time before the building is so weakened as to give way. The firemen require some practice to be convinced of the advantage of this proceeding; not that there is any trouble in pressing them forward, the difficulty rather being to keep them back; but it is much pleasanter to show off the power of their engines outside, than to proceed perhaps on their hands and knees, amid smoke, heat, and a deluge of water, no one being able to see or value their exertions except their own officers.

The firemen in London being constantly employed on weekly wages, give their whole time to their employers, and are much more under command than where men are only occasionally employed. The wages and treatment being liberal, although the discipline is severe, there are generally a considerable number of candidates for each vacancy. Thus good men are obtained, seamen being preferred, as they are taught to obey orders, and the night and day watches, and the uncertainty of the occupation, are more similar to their former habits than to those of other men of the same rank in life. The large number of fires is, however, the principal cause of any advantage the London firemen may possess over those of smaller places, and it is hardly fair to compare firemen who have only an opportunity of attending one or two fires in a week to those who attend nearly three fires a day.

The supply of water is the most vital part of any exertions towards extinguishing fire. Where the pressure is sufficient, and the mains large enough, by far the most economical mode of using the water is to attach the hose directly to the mains. In London, however, that can rarely be done, for several reasons. The greatest number of plugs are on the service-pipes, that is, the pipes for supplying water for domestic and other purposes, which are only open a short time every day. If the cisterns are nearly empty, the pressure cannot be obtained till they are filled. Then, again, the plugs being some distance apart, it is difficult to obtain a sufficient number of jets. But when the plugs are full open $1\frac{3}{4}$ diameter, a sufficient quantity of water is obtained from each to supply three engines, each of which will give a jet equal to the plug if confined to one jet. The pressure also in the mains in London seldom exceeds 120 feet at the utmost. For these reasons the pressure from the mains is seldom used till the fire is checked, when the ruins are cooled by the "dummies," as the jets from the mains are named by the firemen.

London is, upon the whole (except in the warehouse districts), fairly supplied with water for the average description of fires, that is, where not more than five or six engines are required. When, however, it is necessary to work ten or twelve engines, there is very often a deficiency. In New Cannon-street, where some of the largest warehouses have lately been built, except at the crossings of the old streets, there is only a $4\frac{1}{2}$-inch service pipe. In other warehouse districts the supply is very limited indeed, although it is amongst the warehouses that the largest fires take place.

The water companies are generally willing to give any quantity of water, but they object to lay down mains without any prospect of remuneration. The warehouse keepers decline to be at the expense of laying the pipes, and there the matter seems to rest. In most other places of importance, the water is under the management of the civic authorities, and they, of course, endeavour to obtain a good supply of water at fires in warehouse as well as in other districts.

"What is Fireproof Construction?" is a question which has given rise to a great discussion, simply, as it appears to me, because the size of the buildings and the quantity and description of the contents have not always been taken into account. That which may be perfectly fireproof in a dwelling-house, may be the weakest in a large warehouse. Suppose an average sized dwelling-house $20 \times 40 \times 50 = 40{,}000$ cubic feet, built with brick partitions, stone or slate stairs, wrought-iron joists filled in with concrete, and the whole well plastered. Such a house will be practically fireproof, because there is no probability, that the furniture and flooring in any one room would make fire enough to communicate to another. But suppose a warehouse equal to twenty such houses, with floors completely open, supported by cast-iron pillars, and each floor communicating with the others by open staircases and wells; suppose, further, that it is half filled with combustible goods, and perhaps the walls and ceilings lined with timber. Now, if a fire takes place below, the moment it bursts through the upper windows or skylights, the whole place becomes an immense blast furnace; the iron is melted, and, in a comparatively short time, the building is in ruins, and it may be the half of the neighbourhood destroyed. The real fireproof construction for such buildings is groined brick arches, supported on brick pillars only. This mode of building, however, involves so much expense, and occupies so much space, that it

* The branch is the metal piece screwed on to the end of the hose, carrying at its termination the jet.

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cannot be used with advantage. The next best plan is to build the warehouses in compartments of moderate size, divided by party-walls, and double wrought-iron doors, so that if one of these compartments takes fire, there may be a reasonable prospect of confining the fire to that compartment only. Again, cast-iron gives way from so many different causes, that it is impossible to calculate when it will give way. The castings may have flaws in them; or they may be too weak for the weight they have to support, being sometimes within 10 per cent., or less of the breaking weight. The expansion of the girders may thrust out the side walls. For instance, in a warehouse 120 feet × 75 feet × 80 feet, there are three continuous rows of girders on each floor, with butt joints; the expansion in this case may be 12 inches. The tie-rods to take the strain of the flat arches must expand and become useless, and the whole of the lateral strain be thrown on the girders and side walls, perhaps weak enough already. Again, throwing cold water on the heated iron may cause an immediate fracture. For these and similar reasons, the firemen are not permitted to go into warehouses supported by iron, *when once fairly on fire.*

The effect of fire on cast-iron, as stated by Mr. Fairbairn, of Manchester (7th report of the British Association, 1837, vol. 6, p. 409), is, that the loss of strength in cold blast cast-iron, in a variation of temperature of from 26° to 190° = 164° Fahr., is 10 per. cent., and in hot blast, at a variation of from 21° to 169° Fahr., is 15 per cent. Now if the loss of strength advances in anything like this ratio, the iron will be totally useless as a support long before the fusing point is attained.

[To show the effect of fire on iron a few specimens were laid on the table, viz.:—

Nos. 1, 2, and 3.—Three specimens of iron from the engineers' workshops of Messrs. J. Scott Russell and Co., Millwall, 10th September, 1853.

No. 6.—Specimen of slate from the same place.

Nos. 7, 8, 9, and 10.—Specimens of iron from a fire in Covent Garden theatre, March 5, 1856.

Nos. 11 and 12.—Specimens of slate from the same place.

No. 13.—Brick and slate from the same place.

Nos. 14 and 15.—Specimens of iron from the fire in the saw-mills of J. Scott Russell and Co. Millwall, March 12, 1856.]

It is sincerely to be hoped that the clause in the new Building Act, restricting the size of warehouses, may be more successful than its predecessor, for it is not only property that is at stake, but human life. In many of these "Manchester warehouses" there are 50, or 100 and upwards of warehousemen and servants sleeping in the upper floors, whose escape in case of fire would be very doubtful, to say the least of it.

Covering timber with sheet-iron is very often resorted to as a protection against fire; but Dr. Faraday, Professor Brande, Dr. D. B. Reid, and Mr. W. Tite, are of opinion that it may be useful against a sudden burst of flame, but that it is worse than useless against a continued heat. Even cast-iron, 1 inch thick, laid on tiles and cement 3 inches thick, has allowed fire to pass through both, to the boarding and joisting below, merely from the fire in an open fireplace being taken off and laid on the hearth. This arises from iron being so good a conductor that, when heat is applied to it, it becomes in a very short time nearly as hot on the one side as the other. If the smoke escapes up a chimney, or in any other way, there may be a serious amount of fire before it is noticed.

The statistics of fires are much too voluminous for such a paper as this, especially as they have been repeatedly printed already. Mr. Baddeley has, for upwards of twenty-three years, sent the annual list of fires to the *Mechanics' Magazine*, and his mode of treating the subject is very interesting. In the *Quarterly Review* for December, 1854, there is a very elaborate statement of the whole subject, condensing the reports of fires in London for twenty-one years.

I may mention, in conclusion, that fires in London have been doubled since the commencement of the Fire Brigade in 1833; and not only are the "calls" doubled, but the fires at which it is necessary to put engines to work have increased in a much greater ratio, being nearly three times the number they were twenty-three years ago.

Many reasons have been given for the increase in the number, as well as in the serious damage caused by fires of late years. It appears to me that the many improved modes of heating, and the general use of gas, render spontaneous ignition much more common than formerly, and, when premises do take fire, cause the fire to proceed much more rapidly. In 1833, of the number of premises which took fire, barely 21 per cent. (20·9) used gas; while, in 1855, gas was used in upwards of 67 per cent. of the buildings which took fire.

A lengthened and very interesting discussion followed the reading of Mr. Braidwood's paper, occupying, indeed, the whole of two evenings, and in which numerous scientific gentlemen took part. Our space prevents further notice at present, but we shall return to the subject in our next number.

FIRE ADMINISTRATION AND FIRE POLICE.

By Hyde Clarke, C.E.

In continuation of the remarks on Fire Assurance, that I have made on several occasions for some years past, in the *Journal*, I take the opportunity of making some further observations in reference to that subject and to Fire Police, in consequence of the late unhappy destruction of Covent-garden Theatre by fire.

According to my view, in considering the subject of provision against fires, Fire Police is the first thing we have to provide for. The Fire Brigade, meritorious as are its conductors, members, and supporters, is a disgrace to this great metropolis. When it is considered that this establishment, on which the safety of life and property is so much dependent, is not supported from the public funds, but is an almsgiving from other parties, we cannot but regard it as a disgrace.

The Fire Escape Service of the Royal Society for Protecting Life from Fire exposes the metropolis to the same disgraceful reflection. For this, and the Royal Humane Society, we are dependent on the donations of benevolent individuals. Thus, a few are made to contribute for the benefit of the many, and for the relief of the rich.

The first thing, therefore, to be done is the organisation of the Fire Brigade, Fire Escape Service, and Royal Humane Service, as a branch of the Police, although the Police administration is open to many objections. The measures requisite can, however, be carried out on a satisfactory basis. The administration remaining with the Chief Commissioner of Police, a council for this department should be organised, of the President of the Metropolitan Board of Works, the Chief Commissioner and the Assistant-Commissioner of Police, of the architect of the Metropolitan Board of Works, and the City architect, of the engineer of the Metropolitan Board of Works, with four or five architects, civil, mechanical, and hydraulic engineers, and chairmen of assurance companies, to be named by the Metropolitan Board of Works. Thus a body would be formed who could draw up the requisite instructions, and whose opinions could be obtained on the requisite arrangements. Thus the police would be represented, the assurance companies, the architectural profession as the chief advisers on points of construction, the engineers in reference to the machinery and the water supply, and the Metropolitan Board as representing the municipal administration.

The Metropolitan Board of Works, as representing the people of the metropolis, and as the especial guardians of the public buildings and the public health, ought at once to appoint a committee to investigate this subject, and obtain the requisite Act of Parliament.

The Fire Brigade, as now constituted, is as satisfactory as its means enable it to be; but the most essential thing is to give it the requisite extension by paying it out of the police-rate. This would enable it to have the necessary number of stations, and a sufficient staff and supply of engines. As at present constituted, the Fire Brigade cannot afford to have stations wherever they are needed, and the consequence is, in the suburban districts more particularly, houses are burned down before the Brigade, with all their vigour and energy, can reach the scene of devastation. Nearly two millions of people in this metropolis are insufficiently protected, and this is a grievance of such weight that it urgently calls for relief. The Brigade stations are very naturally thickest in those places where the assurance companies have the greatest amount of property at stake; and those parts of the town where houses are more scattered are left to the chance operations of the central brigade stations. When it is considered that only one hundred firemen are provided for the protection of this vast metropolis, it is wonderful more damage is not done.

The Consolidated Fund can justly be called upon to contribute

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largely to the Fire Brigade Fund, inasmuch as it receives an enormous revenue from that oppressive and unequal tax, the Fire Assurance duty. The amount contributed by the metropolis to this iniquitous contribution is probably not less than from 150,000*l.*, to, perhaps, a quarter of a million; and from this the government do not give a farthing for the protection of the inhabitants, but leave the fire insurers to pay the expense of the Fire Brigade.

The parishes should be relieved of their engines and ladders, and, above all, of the beadles and street-keepers; and they should likewise be relieved from the voluntary contributions by which the Royal Society for the Protection of Life from Fire—including their secretary, clerks, and four collectors—are chiefly maintained.

The parish beadles and their tail should be disbanded, a new scale of fines for careless fires be established, and the funds be devoted to the maintenance of the Fire Department. Thus, one portion of the public would be relieved from oppression, and a contribution be obtained towards the general expense. Fines for improperly constructed chimneys, and other infringements of the public safety as to fire, should be devoted to the like fund. In fact, for an efficient Fire Department, the public expenses would not be much greater than at present, while many lives and much property would yearly be saved.

The chief of the Fire Department should be, as far as possible, independent of the Commissioner of Police, and responsible for his department, in which, as now, he should yearly publish a report; but this should be at the public expense, as it is in Paris, New York, and elsewhere. The appointment should be made an honourable one, as it is a responsible one, and we should have an assurance of a fitting successor for Mr. Braidwood, as well as that he shall receive after so long a career a suitable reward. The subordinate officers should have the prospect of promotion, and the certainty of a proper provision in case of casualty in their hazardous career.

Provision should be made that Brigade firemen may be supplied to public establishments on the same conditions as the metropolitan police are now supplied. The Post Office fire duties are performed by Brigade firemen. But this arrangement should be extended to all the government departments; and dock companies, railway companies, theatres, and private individuals, should be allowed to employ the Brigade men. The privileges and powers exercised by the Brigade, as well as their superior efficiency, would soon cause private engines and firemen to be superseded by those of the Brigade; and when the firemen, supported by the dockyards, docks, railway stations, palaces, Post Office, Custom House, Somerset House, &c., come to be included as a reserve, with the great mass of the Fire Brigade, a much more efficient establishment will be obtained, and a greater force can be concentrated on any considerable fire.

A proper organisation of the *personnel* of the Fire Department would be attended with a corresponding development of its material resources. The stations and engines would undoubtedly be increased in number, and before long the engines themselves would be greatly improved, the more particularly if the plan of having a consulting council be adopted, before whom inventions can be laid, and who will have an interest in raising the character of the service to its highest pitch.

When proper funds are provided, not only will more stations be erected, but stations affording greater accommodation, and enabling a larger staff to be maintained, and a better supply of engines and horses. At present the expense of stations falls very heavily on the parties who maintain the Fire Brigade, and many of the stations are leasehold. All the Fire Brigade stations should belong to the Metropolitan Board of Works, be provided by them, and be under their care.

As the Fire Brigade stations are places of observation, and it is in the highest degree expedient for the efficient extinction of fires that early information be given, a system of telegraphs between the stations is of the greatest necessity, and this can alone be provided at the public expense, and be maintained under public protection.

Next to the provision of firemen and engines comes the supply of water, and this is at present in a very unsatisfactory state. With all Mr. Albano's care he could only provide for Covent Garden Theatre a large tank with a few tons of water on the top of the house, instead of a permanent supply by turning on the mains. At the Queen's Theatre it has been found worth while to dig a well on the premises and fill the roof tank from it.

The supply of water for fires and the distribution of it are equally defective. One of the first functionaries needful for a fire is the turncock, as it is seldom the police or the firemen can get at a main having a constant supply. The most efficacious measure for coping with fire is a constant supply of water, as is attained in so many of the large towns of England; whereas the metropolis is given over to the water monopolists, who work the water supply for their own purposes on the cistern system. Thus, no house or building has within it communication with a constant supply of water, and so far from it, a scheme of tricking is devised for restricting the supply of the inhabitants within the narrowest limits. Thus, unless when the municipal authorities and Boards of Health intervene, there is no water supply on the Sunday,—a day on which much water is used for cooking by the working classes,—and the inconveniences are very great. Another trick is to turn on water at seven o'clock in the morning and stop it at eight, at a time when most of the population and the servants are busy with breakfast preparations. The working classes are thus kept without a further supply of water than their small cisterns hold, from eight on Saturday morning to the like hour on Monday, and then the supply, by way of change, is sometimes deferred till eleven. Besides other domestic inconveniences inflicted on the poor, the annoyance from the deficiency as affecting waterclosets may be anticipated.

As this system of trickery is resorted to for house supply, of course it governs the fire supply, although the water companies do profess to supply the metropolis gratuitously with water for fires. The consequence is a needlessly complicated system of fire-mains, plugs, turncocks, and tools, which come together at the moment when speed is of vital importance, to mar the efforts of the Fire Brigade, who ought not to have any trouble. The first step in this matter the Metropolitan Board of Works have to take is to name a committee to consider the supply of water for fires, and such committee will find remedial measures enough to suggest.

One thing requisite is a liberal supply of stand-cocks, as in some other cities, to which hose could be applied in the greater part of the metropolis, and throw a jet at once. All public and private buildings should be allowed to supply themselves with uniform stand-cocks and hose; and hose should be kept at the police stations. Except in the higher parts of the metropolis, where adequate pressure cannot be got, a greater power of instantly coping with fire would be attained.

Light moveable water-tanks would be found useful, to be brought by the Brigade to the scene of fire. These could be filled, instead of the water running into the kennels.

It is well worthy of consideration whether the supply of sea water for cleansing and sanitary purposes, as a substitute for fresh water, proposed by Mr. Francis Whishaw, C.E., Mr. Francis Fuller, and other authorities, would not be equally valuable in its application for the prevention of fires, thus further contributing to economise the supply of fresh water.

In the outlying districts of the metropolis, what with the turncocks and the few Brigade stations, a fire effectually lays hold of a house before relief can be obtained, so that they only come in time to prevent it from spreading to the neighbouring houses.

To effect the requisite reforms considerable funds are needed; but the outlay would be attended by great economy.

In the *first place*, all fines or rewards for engines attending fires should be paid to the Metropolitan Board of Works for this fund.

In the *next place*, should be paid to the same fund all fines for defective constructions.

In the *third place*, a contribution must be obtained from the Consolidated Fund, that is, from the Fire Insurance Duties.

The expense of maintaining the Fire Escape Service would be reduced, so far as the management goes, and would be more fairly assessed.

To afford a proper fire fund the Fire Assurance Duties must be dealt with, as I have often advocated in this *Journal;* for were the Fire Brigade nakedly taken from the assurance companies, and the expense put upon the Consolidated Fund generally, that would be unfair, for it would be taxing the country generally for the benefit of the metropolis alone, and it would be relieving the assurance companies from the expense of the Fire Brigade, without the public, who are assurers, getting any allowance. If the expenses of the Fire Brigade were paid solely out of the municipal taxes, then, too, the companies would be relieved, and the taxes increased, without the assured getting anything.

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There is, however, one course which will meet the difficulty equitably, and relieve all parties.

Let the Metropolitan Board of Works farm from the Government the Fire Assurance Duties within the metropolis; that is to say, suppose the amount of fire assurance duties paid within the metropolis for the year 1856 is 300,000*l.*, or supposing a reduction of the tax in the ensuing session, then on a corresponding basis, the Metropolitan Board shall pay the Government 300,000*l.* yearly, and have the whole disposal of the tax apart from the Government.

Under such an arrangement, all buildings not assured would become liable to assessment for fire assurance duties, as now paid by assured buildings; but the tax would be paid to the collectors of the Metropolitan Board, and not to the assurance companies.

There would thus be a wider area for the distribution of the duty; and there can be little question that the duty would soon be reduced to 2*s.* per cent., and with the progress of the metropolis, to 1*s.* per cent.

In addition to the 300,000*l.* per annum, or fixed sum, paid to the Government, the Metropolitan Board would charge on the duties the cost of the fire department.

As the area of assessment to the assurance tax was extended, progressive reductions of the next year's duty would be announced by the Board.

The companies being relieved from the weight of the tax and the cost of the Fire Brigade, and, it may be added, from much of the risk of fire, would be able to reduce their premiums; and as the reduction of tax and premiums would cause a great extension of assurance, the expense of assuring a simple risk might, within ten years, be reduced from 4*s.* 6*d.* per cent., which it now is, to 1*s.* 9*d.* per cent. On the reduction of the rates, most persons would increase the amount of their policies, instead of appropriating the net reduction to other purposes, while many new assurers would come in. Many persons, whose buildings were theretofore unassured, would become assurers, inasmuch as they would have to pay the tax, which is in its essence a property-tax, whether they liked it or no. Many mechanics, to whom 9*s.* or 10*s.* a year is now an object, would pay 3*s.* 6*d.* a year to assure 200*l.* worth of furniture and tools. To the working classes a great boon would be given, because their chief property is, what may be truly called personal, their furniture, tools, and working stock.

Those now carrying on dangerous trades, and who have to pay high or doubly hazardous rates of assurance, on which the heavy duty is an aggravation, or who cannot assure at all, would be able to do so, because a dangerous risk would be assured for the rate now paid for a simple risk and duty.

Under such a system public buildings could be exempted from duty, and churches, chapels, schools, hospitals and public offices, which are now often left unassured, or are only partially assured, would be fully assured. In the case of a church worth 10,000*l.* for the building, and 1000*l.* for organ and fittings, the organ is, perhaps, assured for 500*l.*, and the building for 2000*l.*; and if the church were burned down it would not be restored in its full state, now that church building rates cannot be levied. At present the cost of assuring the church in full would be 35*l.*—a considerable sum to take out of the church rates. The cost at 9*d.* per cent. would be 4*l.* 2*s.* 6*d.*

Thus, many fine public buildings would be secured to the metropolis in case of casualty, and not, as now, a charity crippled from want of funds for re-erecting the building.

With the establishment of such a system in the metropolis, other districts would profit by it, and in time the whole country would be liberated from the oppression of the Fire Assurance Duties, and be provided with efficient Fire Brigades; for municipal corporations could redeem their fire assurance duties, and county boards hereafter to be established could relieve their districts.

The principle of redemption, compounding, or commutation, is one not unknown to the Inland Revenue Department. In one form or another it is applied to the land tax, to the duties on bank-notes, and to the property and income tax, and no valid objection can therefore be raised against it.

The measure here proposed would enable the Government to maintain a source of revenue which, otherwise, in the pressure of foreign competition, will have to be wholly abandoned.

42, *Basinghall-street*, 10*th May*, 1856.

LIVERPOOL ARCHITECTURAL AND ARCHÆOLOGICAL SOCIETY.

The annual meeting of this Society was held on the 7th of May, at the Royal Institution, Mr. J. Hay in the Chair.

The Secretary announced that Joseph Pepper was the successful competitor for the prize awarded by the council for the students' designs.

The report of the council for the past year was read. After describing the prosperous state of the Society, it stated that the students' designs, which were exhibited and commented on at the previous meeting, "were of a very creditable character, and afforded indications of great industry and ability in the competitors. The council would recommend that a premium be offered by the Society for the best series of sketches of architectural subjects, to be drawn or designed by the respective competitors, not fewer than three in number, during the recess, and sent in on or before the 1st November next; the council to be at liberty to withhold the prizes in case the instructions are not accurately complied with, or if they consider the designs are deficient in merit."—This suggestion of the council was unanimously adopted.

The following gentlemen were elected to serve the respective offices for the ensuing year:—Mr. S. Huggins, president; Mr. J. F. Hay and H. P. Horner, vice-presidents; Mr. Goodall, librarian; Mr. F. Horner, treasurer; Mr. Weightman, honorary secretary.

The President then read the

Annual Address.

After thanking the meeting for their uniform kindness to him during his presidency, and congratulating the Society upon its success, the President continued,—

When we met in October last, the subtle fluid was hourly streaming through the electric wires with momentous news from the seat of war. A government that had been rendered sluggish and paralysed by an unparalleled term of peace and prosperity, was beginning to awake, and, by a different process, a nation quickened by the same peaceful privileges to schemes of eager and gigantic enterprise, was daily approaching a state of absolute antagonism to our rulers, when at length the thunder of indignant but enlightened public opinion charged heavily on the "circumlocution officers" of routine and precedent, and roused them to a state of preparation to have commanded a triumphant, an effective, and enduring victory: when lo! we are suddenly checked in our career to join in the pœans and thanksgivings to the God of battles for a satisfactory peace.

No incident in history ever illustrated our title to the symbol of the noble lion so much as the elastic vigour with which we have laid down our conquering arms to resume the arts of peace. There is a victory, a magnanimity, and a lustre in the transition that is doubly glorious.

It is equally worthy of note that while we have been listening to the distant sound of the battle drum, our progress in the peaceful arts has not been retarded. In the building yards and in the forges of this emporium of commerce might have been heard the voice of the shipbuilder and the engineer directing, in one breath, the construction of the invulnerable floating battery with the elegant and life-like pleasure yacht; the monster piece of ordnance with the delicate machinery of a cotton mill—the one the terrible instruments of destruction and death, the others the mighty pioneers of civilisation, progress, and industry.

While these things have been going on in the shipyards, and in the forges, the handful of bricklayers, carpenters, and stonemasons who have been called to put in order our towers and fortresses of defence have never been missed, and the surplus wealth of our national industry that has continued to flow through the agency of the architectural profession, has not come under the average of former years; on the contrary, I venture to think—nay, to assert—that these two years of turmoil and warfare have tended to sharpen thought, stimulate industry, and shed a more truthful light on benevolence. When I glance at the suburbs of Liverpool, in whatever direction, and mark the countless cottages, villas, and mansions that have sprung up, I judge of the overflowings of wealth; when I pass along the heart of the town and see the palatial piles of offices that are rising in every direction, I form an idea of credit and intelligent enterprise; when I pass into the byeways and highways and note the churches, chapels, and schools that are rearing their spires and their belfries, I form some estimate of the enlightened benevolence of that wealth, and feel that we have a great humanity in our greatness.

But an innate feeling of irresistible progress seems to have pervaded the national mind. It seems to have approached the culminating point of war in earnest, or peace in earnest, and could not longer bear to have the impetus repressed or divided. The latter has no sooner been realised by anticipation of a few months, than municipal bodies and private associations throughout the kingdom are projecting libraries, museums, reformatories, ragged schools, hospitals, asylums, public halls, music halls, town halls, institutes, public parks, galleries, and places of national recreation, amusement, and improvement, giving character and identity to that great and generous utilitarian principle of providing the greatest good to the greatest number of our fellow-creatures.

I cannot proceed without reverting to our entertainment at the Public Library, in Duke-street, on the 19th April, and to state not how much the architectural profession of Liverpool, but the architectural profession of the United Kingdom, along with those who are interested in the kindred arts, are indebted to the chairman of the Liverpool Library and Museum committee for a collection of the most invaluable books so far beyond the means of most professional men—a collection as select and judicious as it is useful and rare (and every day becoming more useful and rare), and open to all the world.

It has been flatteringly remarked in one of our architectural periodicals that the Liverpool Architectural Society threatens to become the architectural society of England. I can have no hesitation in saying that if our Public Library doubles itself in thrice the period of its formation—and I have no doubt it will under such management—that it will practically eclipse all the libraries in Europe, not perhaps in numbers, but in real utility.

It is rumoured that there are nearly two hundred designs sent in by the profession for the proposed buildings to contain these treasures of intellectual wealth. This, to say the least, implies strong and generous faith in the honour and competency of the committee to select; and although there appears to be a divided opinion on the propriety of a second and limited competition, and a final selection being at once made, I feel assured this question is in hands from whom it will receive most cautious and deliberate consideration.

This is obviously no ordinary competition; and if each of the disappointed candidates will for an instant transpose himself into the position of the chairman of the adjudicating committee, and feel how much he has at stake with his professional brethren, he may then imagine the onus of the duty that has devolved upon him, and be induced to exercise towards the chairman of that committee those charitable feelings of reliance on the truthfulness of his intentions, the purity of his motives, and the justice of the reasons which will aid him in his decision.

In the event of a fresh competition between the twelve or twenty, I would respectfully

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suggest that the chairman of the Library and Museum committee do strongly recommend that the unsuccessful candidates selected for recompetition, whether they compete a second time or not, should be rewarded with medals of gold and silver, of graduated value of from 5*l.* to 50*l.* each, as a proof of merit, to attest their place in this arduous struggle.

While it would afford unmingled satisfaction to see the successful candidate spring from amongst ourselves, I have at the same time so decided an opinion as to the paramount interests of architecture at stake, through honourable and fair competition, that I could sacrifice all feeling, even to the weight of a feather, that would incline the balance to anywhere else. With the interests of the profession still in view, and whatever mode may be adopted for the selection of the best designs, I trust they will all be publicly exhibited, along with a careful report on the grounds for which the selections have been made, as I can conceive nothing so excellently fitted to forward and advance the art of architecture, not only amongst its professors but in the mind of the public, as an intelligent prominence given to the reasons for preference of the ideas of one or two out of so large a number for the same object; and I doubt not they will be such as to make us, as citizens, proud of our Exchange, proud of our unrivalled St. George's Hall, and prouder of our Library and Museum.

We were all delighted with the amiable, eloquent, and impartial criticisms of Mr. Verelst last meeting upon the designs for a public square sent in by students; not only every student but every member of the Society must have heard them with pleasure and with profit. I have to state that "Excelsior" is at present taking a holiday on the continent, and cannot be present to receive his well-earned prize. I must also state that I voted for "Excelsior" throughout on all the points—viz., "drawing," "plan," and "design"—in utter ignorance that "Excelsior" was a pupil of our own. His merit is not the less when I mention that such a thing as a street house has not been designed in our office since he was articled three years ago; therefore the work is entirely his own, and our office hours are such as to assure me of his patient and persevering industry at home.

It is to be regretted that we did not receive a dozen of designs in place of three; the students may rely they cannot be more profitably engaged for their future welfare. The royal roads of patronage and influence are fast being obliterated by the true roads of patient and intellectual toil, so that the only avenues to the high places in the profession will ultimately be exclusively tested by the merits of talent and genius through honourable competition.

Let me urge the students to the summer competition; the prize is to be awarded to the best-filled sketch-book—quality before quantity, and variety with quality is to be desired. The last on the list will never regret his pains, and the first and foremost will not dare to rest quiescent on his honours.

There has been rather a lively discussion between Mr. G. G. Scott and Mr. William Tite, on the merits and progress of mediæval and classical architecture; both have been tolerably supported by other writers advocating the respective views of these gentlemen. The subject is by no means exhausted as regards the pen, and scarcely touched as regards the pencil. We have the labours of a host of investigators into the principles of the former, and the pencil has done little more than repeat the past; nevertheless we are rapidly approaching that transition which the knowledge of these principles will enable us to work out in new thoughts and new ideas, so as to enable our age to claim them as its own. On the other hand, we have advanced the Anglo-classic or Italian with the pencil regardless of its principles, and it is still a question whether any amount of investigation will evolve such an amount of mathematically compact and united principles in the latter as in the former; nevertheless the construction and geometrical truths may be seized and applied to all; and the instant they are so understood and applied by the true artist, we shall then simultaneously discover their inexhaustible vitality and universal adaptability to our wants.

If I be correct in this view, as I believe I am, it follows that our profession never presented so cheering and so encouraging an aspect.

None with the slightest enthusiasm for his profession will be bold enough to deny that the true architect would as cheerfully live to work as work to live. It is simply unfortunate that the great majority of the profession are obliged to look to the latter alternative—"daily bread;" and it is bread and water *versus* honour and fame to the most of us, whether it come by one per cent. or ten per cent. How far the present dispute with my lords of the royal commission for the erection of the legislative palace at Westminster, and the highest member of the profession, Sir Charles Barry, may affect the humblest of us, I am at a loss to know; but it is certainly an omen of evil when the nobility of the land, hitherto supposed bulwarks of all that is just, righteous, and honourable, should begrudge or attempt to cut down, the usual and acknowledged remuneration due to the profession, especially for such a work, of which you may safely say that there is not a cubic yard of it that has been erected which did not claim the personal attention and consideration of the architect. Why should Sir Charles Barry be precluded from earning and retiring with a competency at the conclusion of such a work? Divide his claim by the number of years he has been occupied with it—nearly a quarter of a century of the best and brightest section of life; consider the position in society he is compelled to maintain—his office expenses, and a thousand other things besides. Compare these with the emoluments of the church or the bar. There is but one architect for the palace at Westminster, and he pushed and worked and won his way nobly to the single point of eminence. Is he less worthy of the revenue of a bishop or the opulence of a broker?—less deserving of the income of a judge or the countless fortunes realised in half the period by trade and commerce?

I know that an opinion prevails that the connexion he has acquired by so eminent a position is considered to be a counterbalance to any diminution of the regular charges of the profession. I beg to hold a contrary opinion, and could name many architects who are earning a larger annual income than Sir Charles Barry in their profession, and for the very opposite reasons that are claimed for the advantages of his position. For example—the instant that My Lord This or My Lady That are about to erect or rebuild their mansions, and casting about amongst their friends for the recommendation of an architect, the reply in nineteen cases out of twenty is, "O, Barry is too much engaged with the Houses of Parliament; go to Burn, Salvin, Bryce, Deane, or anyone but Barry." Were Barry to live to the age of the patriarchs, he might realise the benefit of his position, although even then very problematical, as younger blood would be following close upon his heels. But pardon me, gentlemen, I am not here to advocate the pounds-shillings-and-pence interest of Sir Charles Barry; I simply ask your consideration of this question as a society, as I am certain that no man who has been five years in practice, and who has done 5000*l.* worth of work, but is intimately acquainted with the margin that is left out of his five per cent. commission for "paying day and way;" and I would seriously ask, "What are the probable effects to the profession at large if the government of this country establish these charges—in other words, 8*l.* for every 5*l.*, or 60*l.* for every 100*l.*?" We may idly imagine that the rule will not apply to private practice; but what will my lord judge say when it is pleaded that the Queen of England only pays Sir Charles Barry three-fifths of our claim? We are not thoroughly acquainted with the details of the differences between my lords and Sir Charles; but we are all acquainted with the fact of the Government asking for competition designs for the public offices, the successful candidate for which is to be paid three per cent., and Government, I regret to think, will get as many designs, I dare say, as would load a railway train for even a trifle less; and some of the parliamentary economists will doubtless trumpet their own praise in having done the "state such service." Let me ask you to cast your eyes over the length and breadth of the land to pick me out an architect who has retired with anything like what is called a fortune, earned in his profession as an architect. I believe not one. But how many builders and tradesmen connected with building are there knighted and baroneted, and wearing their honours and opulence with dignity and decorum? We have Sir Robert Smirke, Sir Charles Barry, and Sir Thomas Deane; but I could name a score of builders, not half the time in business, who could each purchase the wealth of all the three.

Allow me briefly to sketch the duties that an architect is called upon to perform for his client for the benefit of non-professional members. He has first to listen to the wishes of his employer, examine the site of the proposed fabric, the resources for materials, the accommodation required, and the means to accomplish it. Perhaps I may put it into a more tangible shape, and say that a house from 1000*l.* to 6000*l.* or 7000*l.* will pretty generally govern the ideas of our merchant princes during the period of their being engaged in business. Well, the architect being primed with the preliminary facts, prepares sketch designs, and assists his client, with his lady, thoroughly to comprehend them—no small task sometimes, although I must be candid enough to confess the lady is almost always in advance of the gentleman in appreciating the interior arrangements as well as the artistic features of the exterior. These, with probably several amendments or improvements, are finally decided upon, and working drawings and specifications are carefully prepared, with duplicates of the same. Estimates are obtained, which run, as usual, from 10 to 50 per cent. in excess of the means at command, and then comes the toil and annoyance of getting the two elements of accommodation and means to dovetail. That done, and we shall suppose a respectable contractor. The work gradually rises before the daily visits of the gentleman and his lady; and how prolifically their ideas flow in innumerable suggestions for improvements! I need not dwell on the deplorable consequences which such divergencies produce; but the architect must be constantly in attendance to discuss these suggestions, as if he had nothing else to do but attend on them alone. At length all is completed and possession taken; the tradesman's extra bills for pulling down and building up are grudgingly paid, and the architect is about to get his five per cent., when some wicked chimney takes to smoking, a slate has got loose, and there are so many frivolous trifles, that the unlucky architect is made to feel ashamed of receiving his petty commission for which he has worked so hard and endured so much. This is by no means an unfavourable aspect of the case, and the very best view of an architect's remuneration is not for a moment to be compared with the rapid and profitable returns of the builder. Yet an architect is expected to be honest, upright, and incorruptible by "silver or gold" under the strongest temptation. But I humbly submit this is a question which concerns the public, and if the public are not interested in preserving the profession free from and independent of a pecuniary interest with the contractor, we must at once give in, and become involved with the profits of the tradesmen. What then? Why, the architect may then receive ten per cent. easier than five.

With every deference I think it behoves the society to take some legitimate action in this matter, either to memorialise the Government or the Royal Institute of British Architects. It appears to me a highly proper subject for the Institute if it have a purpose in its existence at all; or, if a new committee is to be appointed to go into the whole question of competitions, why may the question of remunerative charges not receive a due consideration and be also included? The subject presents many difficulties, but they are not insurmountable to the patient care of a sound judgment and common sense. With the well digested views of a committee, embodied in a respectable memorial to the Institute, we shall be able to calculate the coherency of the sentiments of the most prominent members of the profession.

It is manifestly obvious that there is much to be accomplished in the first place by the profession itself before the evils of competition as at present conducted can or ought to be remedied. Were our architectural periodicals to discuss the subject more fully and freely in their pages, until the mind of the profession was thoroughly impregnated with its importance, in place of sympathising with the anguish of its victims and heaping invective and abuse upon committees, we might look forward for a change for the better. Were these periodicals sufficiently courageous and noble enough to refuse insertion of certain advertisements under the head, "Competitions," which occasionally degrade their pages, we should have a fountain head the less for propagating the evil they profess to deprecate.

The constructive adaptation of iron for building purposes makes but little progress, after the acclamations by which its birth was heralded throughout the length and breadth of the land in 1851. The Sydenham Palace was very partially purged of the inconsistent, incongruous, and perishing elements of its predecessor. Several attempts are being made to work out a whole with this material; but all are defective in the unity of end to be accomplished, and are faulty in comparison with our brick and stone structures. There will be many failures due before the desideratum of entireness is reached. One of the best is a warehouse erected in Jamaica-street, Glasgow, the name of the architect of which is omitted to be mentioned in the description of it in the *Illustrated London News* of the 15th of March last. The complete absence of support on the street floor, in order to accommodate the shop plate-glass fever, is perhaps the greatest eyesore; otherwise this building is a step in advance.

This subject has been revolving in my own mind from time to time; but to produce a successful result it would involve an outlay of capital and time for which I am quite unprepared. I may, by the way, suggest that if the iron-founder or mechanical inquirer, in conjunction with an architect of constructive and artistic ability, were to direct their attention to this matter, there is ample scope to take a leap considerably ahead of anything yet done. I may further state that the subject occurred to me chiefly with reference to the houses, shops, and offices in the immediate vicinity of our Exchange, where space was so valuable, and security against fire of importance. These buildings would therefore have the entire frame-work of cast and wrought-iron, with floors, ceilings, walls, and partitions of brickwork, and the fronts worked in on the iron framework with coloured ornamental brickwork, having a vitrified glazed surface which could never imbibe dust or become discoloured with smoke; at any rate, five minutes with the garden force-pump would restore the front of such buildings to their pristine purity. This principle, if well carried out, might be applied to our streets generally, as plain and as highly decorated as the circumstances might demand.

Supposing, then, a design on this principle, with this range of application to be well digested and matured, the constructing engineer would require some costly machines and machinery for the skeleton frame-work of these structures to make a start, and unless he staked a further outlay of capital by the erection of a few of these fabrics in some of our busiest streets, and secured himself by patent, he might soon be outrun by greater ingenuity and enterprise. There could be no solid objection to this for the sake of the general interests of our art; but who is likely to become the victim with limited means, and it is seldom that anything essentially and permanently beneficial to the interests of society can be fairly inaugurated without the sacrifice.

There can be no question, however, that something of this sort will eventually be adopted when we look at our exhaustless iron mines and our immense resources of matchless mechanical skill at hand. Moreover, when we consider the effect that a proper system of soundly constructed fire-proof building for the streets of our cities and towns would have on that huge and vicious abstraction of our industrial wealth accumulating in our fire insurance offices, the subject assumes a national magnitude and importance. For whatever may be the benefit of these institutions in the immense revenue which they yield to the Government of the country, the profits to the companies themselves are no less princely and enormous; and although true that the very origin of those institutions arose out of the most kindly and social features of our nature, it is not less true they are on the verge of outliving the end of their institution; in fact, I question whether their existence now is not chiefly as an iniquitous premium to perpetuate a system of building unworthy of our time.

Here, therefore, is a subject worthy of the statist. Let him take the annual destruction of property by fire (an annihilation of our national wealth benefiting none)—let him estimate the cost of insurance throughout the kingdom against this devastating agent—let him approximate by estimate the diversion of these amounts into the legitimate channels of mechanical and professional skill in an improved character of domestic

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architecture for our cities and our towns—and he will find a solution immediately and progressively beneficial to the country at large, so as to justify any government in at once abolishing a vast obstacle to the onward march of our refinement and civilisation. The subject of 75 years' building leases may very well be considered from the same point of view in any legislative measure of inquiry into the evils which retard and hinder our progress in a consistent, safe, and durable system of building.

It must afford unmingled pleasure to every one interested in British art to mark its vigorous and successful development through the honourable channels that are being daily opened for its career by the wise and generous policy of its promoters. If we look to the exhibition in Paris, where it took a highly creditable position, or to the competition for the prizes offered for the best design of a cathedral at Lille, where the first was borne off by an English architect, and silver medals and honourable mention awarded to other English architects. The Barrack competition, too, must have opened the eyes of our government to the fact that there are modest civilians better acquainted with the requirements for accommodating our armies than the officials of the royal engineers. One of the most gratifying movements was the distribution of prizes for art workmanship at the Architectural Museum about the beginning of last month; and here we have the celebrated Ruskin, nothing daunted or deterred from his useful course, taking the initiative in lending his aid to raise the mannikin artist into the artist man, and bringing his heart, head, and hands to work in harmony.

How much are we indebted to Ruskin, with all his faults, inconsistencies, and contradictions? Who but himself could have provoked the stately *Quarterly* and the philosophical *Edinburgh* that they should be diverted from their wonted subjects? and who could have expressed himself so nobly, so encouragingly, so amiably to the meritorious competitors for his prize as the undergraduate of Oxford? We cannot estimate our obligations to Ruskin until we have a photographic impression of the countless minds who have had their attention directed to art, to architecture, and art workmanship through the lofty, the sublime, the generous aspirations of his writings. No matter although we cannot endorse all he says and all he writes—he may have art in these very contradictions and inconsistencies with which he is charged.

Yes, gentlemen, I have no hesitation in saying that Ruskin has done more than any living man to force the public mind into an enlightened contemplation of the majestic and mighty influences of architecture; and this simple circumstance of his lifting up the artisan from his gin-horse human-machine character is a virtue for which he deserves our highest praise.

The subject of improving the building mechanic is one that has often occurred to my mind since the complete failure of mechanics' institutions, and how far this Society might be made to penetrate this important section of architectural craftemen, especially the mason, the bricklayer, and the carpenter, with a proper and intelligent knowledge and love of their pursuits. I am convinced if we had the advantages of a building suitable for such purposes, as a society like ours should have, with a library and museum, and one or two good classrooms for these workmen for modelling semicircular, pointed, groined, and elliptic arches, making centres, arranging the joints of masonry on masonic principles; carpenters making themselves acquainted with drawings, joints of carpentry, and the geometrical principles of construction, with the numberless other details and matters connected with the respective branches in which they might be engaged about a building—we should hear less of that discontent and dissatisfaction which end in collisions with their employers and in ruinous strikes to themselves.

I may suggest now, that as we could not exist merely as a society of professional architects, from our numerical weakness, and as many of our principal builders afford us their willing support by their membership, whether it might not be advisable to appoint a committee to discuss this subject, and to call a meeting of the tradesmen of Liverpool to establish classes in connection with this society, or that the members of this society might exercise a supervision over their studies. Were the builder to give due encouragement to such a project it might easily be made self-supporting, with a few of the best amongst themselves as leaders or instructors; and the professional members of this society, by rotation or election, to be appointed as honorary visitors to inspect these classes at least once a week, would surely be a pleasanter duty than that of the medical man, who is proud of his appointment to be the gratuitous visitant and adviser of our hospitals and dispensaries.

As I have already stated, I merely throw out the crude suggestion for the consideration of the new officers that have been elected to conduct the affairs of this society; and if I can be of any use beyond fulfilling the duties of my ordinary membership, my best services are at your command.

I feel persuaded that anything we can do to develope and expand the minds and excite a love and an interest in the hearts of all the various workmen connected with the practical department of architecture, will be well rewarded to us as individuals and as a society, in seeing the immediate signs of mental improvement and emulative skill amongst these men.

There is no selfishness in art. The instant you fence it in with cunning, secrecy, and conceit, it withers and dies: bring it to the sunshine if you expect it to blossom and bring forth fruit, and, as "iron sharpeneth iron," bear in mind that in your teachings to the mechanic you are illuminating a power which, though it may feebly reflect and not directly add to the lustre of your own, must of necessity expand its sphere and increase its power.

INSTITUTION OF CIVIL ENGINEERS.

April 22.—JOHN HAWKSHAW, Esq., Vice-President, in the Chair.

The Paper read was "*On the Junction of the Atlantic and Pacific Oceans, and the Practicability of a Ship Canal, without Locks, by the Valley of the Atrato.*" By F. M. KELLEY, U.S. (America).

It was stated, that the consideration of this subject had become urgent, and the adoption of some definite plan indispensable, in consequence of the commercial activity which had resulted from the discovery of gold in California and in Australia, and the rapid development of trade throughout the whole of the Pacific. But the very extension of trade had introduced new elements into the problem; the larger dimensions now given to ships, and the increasing value of time, rendered it necessary that the proposed communication should be of a sufficient width and depth to permit the passage of the largest class of vessels, and that it should, if possible, be constructed without locks, so as to insure economy of time as well as of distance. It then gave a brief review of the different routes hitherto proposed, and the objections to which they were open.

The Tehuantepec route would require 150 locks; even then it would be 210 miles in length, and great improvements would be necessary in the harbours at both ends. The very unsettled state of the government in Mexico, rendered this undertaking most hazardous at the present time.

The Honduras route, 160 miles in length, was open to the same objection as to locks; the summit level was very high, 2681 feet above the sea; and, moreover, sufficient water could not be obtained for the number of locks required.

The Nicaragua route, 194 miles in length, would have twenty-eight locks; the river San Juan would require to be deepened throughout; 47 miles of additional canal must be made; great improvements must be effected in the harbour of Greytown, and a new harbour altogether constructed on the Pacific. The modification of this project, by which the port of Realeja would be the terminus on the Pacific, would increase the distance about 100 miles, and require great additional lockage, which, it was very doubtful whether the lake Leon could supply.

The Chiriqui route was considered utterly impracticable by M. Hellert, who found that the supposed passage through the mountains offered the most formidable difficulties.

The Panama route would require thirty-six locks and six aqueducts, and the approaches on either side would demand vast alterations to adapt them to the present wants of commerce.

The San Blas, or Mandingo bay route, had never been sufficiently explored, on account of the decided hostility of the Indians; moreover, that part of the Atlantic was beset with reefs and shoals, and there was every reason for believing that there was no depression in the mountain range.

The Darien route was only partially explored by Mr. Lionel Gisborne, who reported favourably of its capabilities; but subsequent expeditions had invalidated these conclusions, and tended to demonstrate that the Sierras Lloranas formed an unbroken chain from the gulf of San Blas to the gulf of Darien. All explorers agreed on the decided hostility of the Indians, and, with the exception of Dr. Cullen, who averred that he had repeatedly crossed the isthmus at that point, no subsequent explorer had succeeded in traversing it. It was proposed to construct a canal without locks, but the great difference in the height of the tide at the two extremities (25 to 30 feet in the Pacific, and only 2 feet in Atlantic) would produce a tidal current of such force as to endanger the works, and materially interfere with navigation.

The Atrato route had already been pointed out by Humboldt, as likely to afford one of the best solutions of the problem. It was stated, that the river Atrato flowed almost due north for a length of 300 miles, in the midst of a vast alluvial plain, between two ranges, resulting from the bifurcation of the Andes; it then discharged itself by nine mouths into the Atlantic, by the bay of Candelaria in the gulf of Darien. The upper part of the river had been carefully explored by Messrs. Trautwine and Lane, who had both reported against the feasibility of any plan for uniting the head waters of the Atrato with those of the San Juan, which flowed into the Pacific. An exploration on the Pacific side, led to the discovery of a depression in the mountain chain between Punto Ardita and Punto Marzo, which was found to correspond in an almost direct line eastward, with the Truando, one of the most considerable western affluents of the Atrato.

The route, more especially advocated in the Paper, would commence on the Atlantic side, at the estuary of the Atrato, by widening and deepening one of its entrances, removing the sand bars, and stopping up by breakwaters and dams, the remaining mouths, so as to direct the full force of the current into the branch called Cano Coquito; or an entrance might be effected by a side cut from the bay into one of the mouths, and the erection of guard gates at each end, by stopping the current, would prevent any deposit or bar outside. At the distance of 2 miles from the mouth the river deepened to 30 feet; and from this point to the mouth of the Truando was no where less than 47 feet, with an average width of 350 yards. It was then proposed to follow the Truando for 36 miles, deepening and widening its channel, where required, to a point named Townsend's junction. Up to this point, the works required would be very simple, as the banks were principally levels, formed of sedimentary deposit, and the soil of the bed of the river was of the same character. From Townsend's junction, an open cut was contemplated for a distance of 13 miles. It was then proposed to tunnel through the base of the ridge, a length of 3¼ miles. A double tunnel was recommended, as the width (200 feet) would require a single arch of too great a height: the division into two arches would also have the advantage of precluding any possibility of collision. The height proposed (120 feet) would be sufficient to allow of the passage of the largest vessels, by merely lowering their top-masts. From the tunnel to the Pacific, a distance of 8 miles, the canal would follow the valley of a small stream, and debouch into Kelley's inlet.

The line would thus uninterruptedly proceed, without locks, direct south, from the bay of Candelaria to the junction of the Atrato, 7° 15′ N. lat., and 77° 8′ 32″ W. long.—a distance of 67 miles 1436 yards, whence it would diverge by the Truando to the south-west, and terminate at the peninsula of Paracuchichi or Kelley's inlet, 6° 57′ 32″ N. lat. and 78° W. long.—a distance of 63 miles 1216 yards. It would thus have a total length of 131 miles 892 yards, with a minimum width and depth throughout of 200 feet and 30 feet respectively. The most important point to be considered, was the rate and direction of the flow of water from the junction of the Truando with the Atrato, and the supply which might be depended on at that point. It had been ascertained by Colonel Totten, the engineer of the Panama railway, that the mean level of the two oceans was very nearly, if not entirely, similar. The

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difference in the height of the tides at the two extremities of the proposed route was found to be—at the entrance of the new river in the Pacific, 12 ft. 6 in. at spring tides, and 10 ft. 11 in. at neap tides,—while the tidal wave of the Atlantic, at the mouth of the Atrato, never exceeded 2 feet at any phase of the moon. After careful observation, Capt. Kennish had fixed the height of the junction at 15·2 feet above the mean tidal level of the two oceans.

The junction of the Truando with the Atrato would thus be 9 feet above the Pacific at the highest tide, and would flow down it with a velocity equal to that head; while, at the lowest tide, the velocity would be equal to a head of 21·45 feet. The summit being at the same height from the mean level of either ocean, and the distance being nearly equal, their average rate of current would be nearly the same,—about 2½ miles per hour. As far as theory could elucidate the tidal influence of the Pacific, it would extend to Townsend's junction, and pass under the fresh water coming down the river, without commotion either at flood or ebb. That part of the river between Townsend's junction and the Pacific, would be slightly agitated by the rise and fall of the tide, but the velocity of the current would be scarcely affected.

By careful calculation, it had been ascertained that the discharge of the Atrato was 667,014,600 cubic feet per hour, and the mean discharge of the new river would be about 42,000,000 cubic feet. Now, if this were taken solely from the bed of the Atrato, it would only reduce that river one-sixteenth, and its surface level 3¾ feet, the Atrato being 58 feet deep at the point of junction with the Truando.

The principal advantages which gave the proposed route the pre-eminence over all others were claimed to be:—1st, that the two oceans could be thus united by an open channel, without locks or any other impediment; 2ndly, that the width and depth would be sufficient to allow of the simultaneous passage, up and down, at all times, of the largest class of vessels; 3rdly, that excellent harbours existed at both ends, requiring but little improvement, and at all times perfectly accessible; 4thly, that the route passed through a country in undisputed possession of a legal government, and among a people favourable instead of hostile to the undertaking.

A summary of the estimated cost of the canal, including the works of every kind throughout its whole length, with lighthouses, piers, depots &c., as also the execution, medical, and commissary departments, was annexed to the Paper. The total, including all contingencies, was fixed at 145,407,042 dollars, or 30,000,000*l*. In constructing the canal of a width sufficient for the passage of one ship at a time, the estimate would be reduced nearly one half.

The vast saving in time and distance, which would be effected by this canal, was then dwelt upon; from New York to San Francisco, it would be no less than 13,000 miles, and proportionately large for all the ports in the Pacific. Details were given of the rapid development of trade, which was annually increasing between Great Britain, France, and the United States—and the Pacific; and also an approximate calculation of the commercial value of the canal.

In conclusion, the author repeated that the plan developed was, perhaps, not the only practicable one,—that although the information contained in the Paper had been obtained, by sending to the Isthmus four different corps of engineers, fully provided with instruments for levelling and surveying, and they had made complete plans and sections of the route,—yet that a more extended survey might suggest the superiority of selecting some other affluent of the Atrato, and some other terminus on the Pacific. His principal object had been, to show the practicability of communication between the two oceans by the valley of the Atrato, and that it possessed peculiar advantages for rendering that communication as large and open as the present wants of commerce imperatively required. If such was the case, he thought that it was worthy of an official survey and thorough examination, by the governments of the great commercial nations of the world.

April 29.—Robert Stephenson, Esq., M.P., President, in the Chair.

In the discussion upon Mr. F. M. Kelley's Paper, it was admitted, that a correct description had been given of the routes hitherto proposed and of the valley in question, but that the route by Panama would be found the most economical and most convenient, if the communication was made between the river Chagres and the Rio Grande, where there were only 15 or 16 miles from tide to tide, instead of by Chorrera, as proposed by M. Napoleon Garella.

It was objected, that Mr. Trautwine, when starting on his expedition, was not supplied with proper instruments for taking a correct survey, and, therefore, that his account could not be implicitly relied on; that Captain Kennish, on his return to Carthagena, was also in possession of but imperfect levels; and that, if the height of the junction of the Truando with the Atrato was not absolutely correct, it would invalidate all the calculations of the work to be performed. But even assuming the figures and levels of the author, it would hardly be possible to execute works of such gigantic proportions, without a great sacrifice of life. It was true that Chagres and Greytown were the two most unhealthy places in Central America (and perhaps even in the world, 400 out of 600 of the Irish workmen employed on the Panama railway having died in three years, and H.M.S. *Rosamond* having lost more men in six months off Greytown than during a three years' station on the west coast of Africa); but the valley of the Atrato was also very unhealthy, as was evidenced by the state in which Captain Kennish returned, after his exploration. If the necessity for a tunnel was granted, then other places might be found more advantageous for inter-oceanic communication, and Darien presented greater facilities.

Another objection to the proposed route, was the great length of the canal, entailing the employment of steam-tugs, which would be found more expensive than trans-shipment by the Panama railroad. Particulars were given of the height of the range of mountains running through Central America, more especially opposite port Escosces: the summit level was stated to vary between 950 and 1150 feet, and the apex of the ridge, or back-bone, of the Andes to be so narrow, as not to allow of more than five men walking abreast, even supposing it to be cleared of trees. But the chain of the Andes had not been sufficiently examined to ascertain whether or not it was unbroken between the Napipi, where the depression was found to be 300 or 400 feet, and the Panama railroad, of which the summit level was only 250 feet. This was a most desirable point to be assured of, before coming to any determination upon the best route; and it was also of great importance that the coasts on both sides should be accurately surveyed, to fix upon good harbours, for it was next to impossible to create them; the maps and charts at present in use were not to be relied on. It was doubted, also, whether the traffic would ever repay the cost; for the route from England to Calcutta or Hong Kong was actually 600 miles longer by Panama, than by Cape Horn: although it was, of course, admitted that the former route had the advantage of calmer seas and of the absence of wind, and that this was no argument against the American trade justifying such an expenditure.

The results of observations with the mountain barometer were also given, showing that its variations constituted a regular tide, by a knowledge of which, calculations could be based with sufficient accuracy for preliminary surveys; as they would never vary more than 10 feet from those obtained by sections run with instruments.

It was contended on the other hand, that Mr. Trautwine, Mr. Lane, Mr. Porter, and Captain Kennish, had all been furnished with proper instruments, and that the spirit level had been used for the survey of the whole length of the Atrato, and from the Pacific, on the west, over the summit of the Andes, down to the river Truando on the eastern side; that Captain Kennish was thoroughly qualified for the task he had undertaken: and that the five different surveys, which had been undertaken at different times, and by different persons, all agreed in their results. It was admitted that the whole of Central America was very unhealthy, but it was stated that the proposed route was less so than the Isthmus proper. It was submitted, that these were not the questions at issue, but whether a practicable route could be made between the two oceans, by the valley of the Atrato, and whether sufficient evidence had been shown to authorise an official survey.

A letter was read, addressed by Baron Von Humboldt to Mr. Kelley (after examining the maps and plans), expressing great confidence in the survey made and levels taken by Mr. Kennish and his predecessors. The large number of maps and sections, taken on so large a scale, furnished all the elements necessary for forming an opinion of a possibility of a communication through the mouths of the Atrato, by the Truando, and by a canal to the Pacific. The failure of the expedition in 1852, and subsequently, for exploring the mountainous country between the gulf of San Miguel and Caledonia bay, might be ascribed to the want of such plans.

Humboldt expressed an opinion that a free and open discussion would demonstrate the relative advantages and disadvantages of each proposed locality, and there would really be little difficulty in tracing the proper route, wherever there were good plans and sections, such as had been made under Mr. Kelley's directions, of the valley of the Atrato; his opinion in favour of that route, as compared with all the others, had always been strongly expressed, and in his works he had even given all the details he had collected, relative to the small canal stated to have been made, in the year 1778, by the Indians, under the directions of a monk, the Curé of Novita, in order to unite the waters of the river Raspadura with those of the river San Juan, and thus establish a water communication for canoes across the isthmus. He alluded also to the labours of Captain Fitzroy, R.N., who had, in his report on the isthmus of Central America, descanted on all the known routes; and he recalled the statement of Lieutenant Wood, R.N., when surveying the coast, to the effect, that he travelled on foot, with native guides, from Cupica to the Napipi, in which he bathed, and returned to his ship within six hours, and that the most elevated ground passed over did not exceed 300 or 400 feet. In fact, Humboldt looked upon the proposition of forming an inter-oceanic canal by the valley of the Atrato as perfectly feasible: and he even added "without locks, or, if possible, without tunnels."

It was due to Mr. Kelley to state, that he did not appear as the agent of any other persons, but that he had caused these various surveys to be made solely at his own cost, and that he had already expended large sums for the prosecution of these investigations, which were carried on under his direct suggestions. In further explanation of Mr. Kelley's views, it was stated, that originally he had been favourable to the route by the Atrato and the Raspadura; but subsequently he

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became convinced that the route by the river Truando to Humboldt bay would be preferable. He had therefore instructed Mr. Kennish and Mr. Lane to survey that part of the country, and the result had been that the latter route was the one he at present recommended. He was, however, by no means prejudiced in favour of any one particular route. His anxiety was that very accurate and extensive surveys of these districts should be made, under the auspices of the governments of Great Britain, France, and the United States, and he believed that part of the isthmus would be found to present more favourable features than any other. With regard to the river Atrato, it was mentioned, that it was only to be compared in magnitude with the largest of the American rivers, and was known to be navigable for the largest ships, as far as beyond the junction with the Napipi. It would, therefore, not require any change below that point, and the nature of the climate was such as to preclude the probability of the supply of water failing at any season. It also drained the whole valley, in which rain fell for nine or ten months in the year, besides which it received a number of rivers, some of which were of equal size with the Truando, the current of which it was proposed to reverse, so as to turn the water of the upper part of the Atrato into the channel of the Truando, and thence into the Pacific.

Although the mean level of the two oceans was generally agreed to be the same, yet in the northern and narrowest part of the bay of Panama, the tide rose 20 or 30 feet, whilst at Humboldt bay, to the south, it did not rise more than 12 feet. The high tide level at this latter point was, therefore, nearly on a level with the junction of the Truando and the Atrato—so that the current would not be so great as to prevent navigation, or to damage the works in the channel, as it had been contended would be the case if a canal were made across the narrow part of the isthmus, where the lift of the tide was greater.

In concluding the discussion, it was stated, that the Institution was very much indebted to Mr. Kelley for the Paper he had brought forward. It gave a clearer insight than any of its predecessors into the difficulties of the whole problem of an inter-oceanic canal, and it suggested a route which possessed greater facilities than any other that had been proposed. The English, French, and United States' governments, entertained enlightened and enlarged views on the subject, and it was believed, that at the proper moment they would lend their strenuous aid in furtherance of this great question, so important to the commercial and political interests of the whole world.

May 6.—ROBERT STEPHENSON, Esq., M.P. President, in the Chair.

The Paper read was "*On the Progressive Construction of the Sunderland Docks.*" By JOHN MURRAY, M. Inst. C.E.

The very considerable shipping trade of the port of Sunderland had hitherto been conducted entirely in the tideway of the river Wear, which, even after all the successive improvements of the channel, only afforded 60 acres of water surface, reduced at low water to about 40 acres, much contracted by the shipping. Nearly all the vessels took the ground when the tide was out, and were liable to be strained, whilst during floods, especially when floating ice was coming down, they were frequently severely injured; the evident remedy for this condition was the construction of docks, for which many designs were submitted by eminent engineers, but nothing was executed until 1838, when a dock of about 6 acres, with a tidal harbour of 1 acre, was constructed on the north side of the river, by Mr. Brunel, for a company. The principal collieries being, however, situated on the south side of the Wear, and the great mass of the inhabitants being located there, it was necessary to have some adequate accommodation for the trade, which was being attracted to other ports, offering greater facilities and more safety for the shipping. Parliamentary powers were, therefore, obtained in 1846, for the construction of docks on the south side, by a Company, of which Mr. G. Hudson, M.P., was the chairman, in accordance with the designs of Mr. John Murray, the author, who had for many years directed the consecutive improvements of the river Wear, and the works at the mouth of the harbour.

The site selected for the docks was a ledge of rough rocks, situated on the sea shore, between the south pier and Hendon bay. According to the parliamentary plan, the northern basin was proposed to communicate with the river Wear by two passages of 45 feet and 80 feet in width, with an area of 2½ acres; this was connected, by two locks of 45 feet and 60 feet in width, with the wet dock of 27¼ acres, which again had two similar lock-openings, at the southern extremity, into a half-tide basin of 4 acres, connected with a tidal harbour protected by rubble stone breakwaters in Hendon bay, so as to permit vessels to get direct to sea, without passing into the river Wear; the contemplated total water area was about 47 acres.

The staple business of the port being the shipment of coals, of which about 1,500,000 tons were brought to Sunderland in 1846, every facility was provided by timber staiths for the colliers when loading at their berths, and the dock being designed for this class of shipping, was, for economy, to have the sides sloping and pitched with rubble stone.

Great doubts were entertained as to the practicability of this project, which certainly did apparently offer considerable difficulties—in constructing groynes which would maintain a barrier of beach or shingle, sufficient to check the inroads of the sea; in keeping down the water during the execution of the works, and in retaining it in the dock after its completion. The two latter objections were replied to, by showing what had been done at the north-side dock; but the first still remained doubtful. In order to settle the point, it was decided to erect three groynes at the northern end, and if they produced the effect of causing a deposit of sand between them, by the waves in their travel from north to south, it was considered, that when the groynes were connected by the excavated material from the dock, a consolidated embankment would be formed, impervious to water from the sea, by the sand being washed into the interstices, and capable of retaining the water in the dock. The result was perfectly conclusive, as long before the completion of the groynes in 1847, a considerable deposit of sand had been effected. Subsequently a half-tide basin was formed at the northern end, and, in accordance with suggestions made by Mr. Rendel, the quay in front of the tidal basin was entirely removed, so as to leave the whole width open to the river.

By means of an embankment, the head of Groyne No. 2 was connected with the adjacent high ground, and the material from the excavations, &c., being deposited, an area was reclaimed from the sea, which allowed the work to be executed by regular day work, instead of being performed in the intervals of the tides.

It was then determined to construct the dock for general commercial purposes, as well as for the shipment of coals, by substituting vertical walls for the slopes; to increase the depth to 24 feet below high water of ordinary spring tides; and to lay the cills of the entrances at 20 ft. 6 in. below such tides, so that the gates might be opened for the admission and departure of vessels for two hours before and after high water, without locking.

As soon as the contract was let to Messrs. Craven, steam engines were erected for pumping, &c., and means were established for hauling away the excavated marly rock for depositing between the groynes, &c.; a timber barrier or dam was soon formed, stretching from the table-land of the Town Moor to the head of groyne No. 3; and clay from the excavations was deposited against it, and it was ultimately united with the barrier embankment; by which means the tide was excluded from the site of the northern portion of the great dock. Groynes Nos. 4 and 5 were completed in August and October, 1847, and the first stone of the half-tide basin was laid on the 4th of February, 1848.

In order to insure uniformity and goodness of quality in the mortar employed, an establishment was created by the Dock Company for burning and grinding the blue lias limestone and pozzolana, and making the mortar for sale to the contractors.

Whilst the filling up between the groynes was proceeding, a barrier of timber uprights, with raking shores and planking, backed with clay, was run out from the cliff of the Town Moor, to join the head of groyne No. 5; and thus the second area of the great dock was reclaimed from the sea. Groynes Nos. 4 and 5 having been previously connected by deposited material, groynes Nos. 6 and 7 were completed in 1848.

Another barrier of timber was, in the meanwhile, formed at the southern end; from the high ground to the head of No. 7 groyne; and thus, before the end of 1848, the tide was excluded from the entire area of the great dock. The rock was then excavated to the full depth, and a cofferdam was placed across the end, in order to permit it to be lengthened at any subsequent period, without disturbing the shipping in the dock.

The groynes served to maintain the whole embankment between the south pier and groyne No. 7, a length of 1120 feet at a cost of 13*l.* per lineal yard of coast; a much cheaper rate than any sea wall or glacis could have been executed for, and the success was perfect.

These groynes had been so fully described by Mr. W. Brown in his Paper on them, read to the Institution in 1849, that they were merely mentioned in the present Paper; they were generally constructed of rubble stone hearting, and the bed and coating of freestone, laid in pozzolana mortar, the joints being stopped with the best Roman cement. The total cost of the seven groynes, varying from 210 feet to 360 feet, with slopes from 1 in 18 to 1 in 32, situated at distances of 350 to 450 feet apart, was 14,480*l.*, or 19*l.* 16*s.* 3*d.* per lineal yard of groyne.

At the termination of Messrs. Craven's contract, there was available, for commercial purposes, an area of 12 acres of embankment, exclusive of the quay, &c. For a long time one pumping engine of 30 h.p. sufficed to keep dry the whole area of the works; another engine of 35 h.p. was subsequently added, in case of accident, but no difficulty was experienced in keeping the water down.

A series of jetties were projected from the western quay in such a manner, that the vessels overlying each other could be loaded with great facility. Four vessels could therefore be accommodated in the space usually devoted to one ship. Fifteen coal-shipping drops were also erected, and the railways so arranged as that the loaded wagons ran by their own gravity to be discharged, and when emptied returned also by their own gravity, on other lines of railway, to the standing places appropriated for them.

The dock gates, constructed by Messrs. Hawkes, Crowshay and Co., were composed of cast-iron framework, lined and covered with teak planking.

The next operation was the removal of a large shelf of rock, situated

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in the river, immediately opposite the front of the tidal harbour. This was effected by means of a coffer-dam, which enabled the rock to be excavated to a depth of 4 feet below the gate-sills, or an entire depth of 10 feet below low water of ordinary spring tides.

These proceedings enabled a wet dock of 18½ acres, a half-tide basin of 2½ acres, and a tidal harbour of 2½ acres, connected with the river Wear, to be opened for commerce in June 1850, and the other portions of the design were then immediately thought of seriously, as the facilities already afforded produced an increase of trade, and caused the port to be frequented by larger vessels. It thus became imperative to execute the original design of having an opening directly to sea, without going into the river at all. A comprehensive design was, therefore, made, and a new series of groynes, Nos. 6, 7, and 8, were commenced in 1850, and groynes Nos. 2 and 3 were reconstructed in positions to suit the extended works; thus reclaiming an area of very valuable land.

The excavation of the southern half-tide basin, the building of its walls, with the outer and inner entrances, and the construction of the eastern pier, were proceeded with; great part of the latter being executed by means of the diving bell and diving dress. A timbered structure was then commenced, from the embankment towards the south pier; the piles were connected by planking, protected by clay and rubble stone. The pier head was in this manner attained, and it was ultimately intended to raise it with rubble stone to the level of high water spring tides.

The channel coffer-dams were commenced in the spring of 1853, and in December following, the old dam in front of the outer entrance was removed, and the excavation of the rock in the channel was vigorously prosecuted, the material being drawn up inclines of 1 in 6½ by a locomotive engine, running upon the level ground at the top of the embankment. This was found to be cheaper than using a fixed engine.

A second coffer-dam was formed in skeleton to the east, or seaward of No. 1 dam for its protection. It was closed in August 1854, and was in like manner protected by the coffer-dam No. 3 in skeleton; which last was completed in June 1855. These precautions were necessary, as the dams were so exposed to the action of heavy seas, and so near to the brink of deep water.

Upwards of 124,000 cubic yards of marly rock and other materials were excavated from the channel, without the sea ever making a breach in these coffer-dams or any interruption of the work occurring, although the channel was excavated, throughout its entire length, to a depth of 12 feet below low water of spring tides. The width at the top near the outer entrance was 240 feet, and at the seaward end 107 feet; the sectional area being reduced in order to keep up the force of the current from the sluices, by the aid of which it was intended that the channel should be freed from any deposit of sand or other material. Dredging would have been an expensive system, and not to be depended upon in so exposed a situation; therefore scouring was resorted to, as the most effective method, in such a depth as 12 feet below low water of spring tides. After careful examination of all the best examples of sluicing, both abroad and at home, the author devised a series of eight main scouring conduits, each 9 feet high and 7 feet wide, having a combined area of 504 square feet; they were situated four on each side of the entrance, and were closed by shuttles which could all be severally or simultaneously opened and shut by the same hydraulic power as was applied by Messrs. Armstrong and Co., for working the gates, bridges, and other machinery of the docks. A discharge was calculated on from 34 acres of water, 4 ft. 9 in. in depth, and assuming that quantity of water to be discharged from the eight sluices in fifteen minutes, at the period of low-water of spring tides, properly proportioning the area of the sluices and contracting the seaward mouth of the channel, it was presumed, that by heaping up the water in mid-channel without any means of lateral escape, an altitude would be attained, which would generate a sufficient velocity to produce great scouring effect to a considerable distance. Beyond the pier head the depth of water was great, and no injurious deposit could take place there, as the littoral currents would carry everything away.

The mean velocity of the issuing water was 6 feet per second, which would be reduced at the pier-heads, 350 yards from the sluices, to 3 miles per hour at the bottom of the channel. This current was evidently sufficient to carry away all deposit, and yet would not injure the bottom, which, at the outlets of the conduits, was pitched for some distance with large blocks of rubble stone set in pozzuolana mortar.

The trade of Sunderland had always been seriously inconvenienced by the undue retention of vessels in the river Wear, during certain winds and at certain times of the tide, as there was not sufficient water on the bar to enable heavily laden vessels to enter or to leave the port except at spring tides. The southern outlet of the dock was intended to remedy this inconvenience, and at present the largest vessels could put to sea without passing into the river, and thus could entirely avoid the bar. In fact, loaded vessels could enter or leave the dock during 20 hours out of the 24 hours, and vessels in ballast could pass in, or out even, at dead low water. From 50 to 80 vessels could be locked through during each tide, and as many as from 80 to 100 could be passed by steam-tugs before the ordinary closing of the gates.

The gates, which were of cast-iron, covered with teak planking, were 60 feet wide between the hollow quoins; they could be opened or shut in about two minutes, by the hydraulic power derived from a pumping engine of 30-horse power, which forced the water into an accumulator, whence it was conducted to the various rams under a pressure of a column of 900 feet in height.

Provision was made by the disposition and form of the piers for sheltering the entrance from the anticipated violence of the waves at the sea outlet, and the precautions taken were very effectual in preventing any excessive agitation within the channel.

A description was then given of the works connected with the southern extension of the dock. Two of the five groynes had been constructed by Mr. W. H. Brown. An excavation of 13½ acres, surrounded by walls, had been added to the great dock; but the remaining three groynes, and the timber pond of about 10 acres, were not yet completed. In the progress of these works it was necessary to remove the dock coffer-dam, and to execute several other somewhat hazardous works, which were, however performed with perfect success.

A graving dock was now in course of construction at the northern end communicating with the tidal harbour and the river. The width between the hollow quoins would be 45 feet, the length 345 feet, with a width at the bottom of 25 ft. 8 in. and at the top of 64 feet. This would complete the works, as far as at present projected, at a cost of 650,000*l.* and afford an area of water surface of upwards of 66 acres, and an area of quays, &c., of 80 acres, in obtaining which about 127 acres were reclaimed from the north sea. The depth of water in the dock, at ordinary spring tides, was 24 feet; and the total quay space in the great dock was 7622 feet, with 15 self-acting coal drops completed, and 10 more to be added hereafter.

A tabular statement of the general particulars of areas, depths of water, rise and times of tides, and of prevalent winds, &c., completed the Paper.

May 13.—In commencing the discussion of Mr. Murray's Paper, it was suggested, that more information should be given as to those parts of the work which presented the largest amount of novelty, or which had required the greatest exercise of skill in their execution. The site of the docks was very peculiar, inasmuch as they had been constructed on ground gained from the sea by the action of groynes projected from the shore. There had been, originally, much doubt as to the feasibility of that plan or mode of proceeding; it had, however, proved very successful.

The dams employed were novel in construction—apparently cheaper than usual, and had been used with success in exposed positions. There had occurred some casualties with one of these dams, which were most ingeniously met, and would be interesting features in the Paper, if added before publication.

All the harbours on the north-east coast suffered more or less, from the formation of bars across the mouths of the harbours themselves, or of the rivers leading to them, the difficulties in keeping open the channels were considerable, and the scouring power hitherto employed had not been very successful, the system used at Sunderland appeared to be better devised, and the results were stated to be superior to anything attained elsewhere; it would be very desirable to be well informed on all these particulars.

It was explained that the author had refrained from noticing the groynes very particularly, because their construction had been minutely described, in the Paper already presented to the Institution, by Mr. W. Brown, (Assoc. Inst. C.E.) The effect produced by the three southern groynes placed seaward of those originally constructed, had been to collect a mass of sand and *debris* on their southern sides, whilst the old groynes at the northern end of the embankment collected the sand on their northern sides. This apparent anomaly was due to the action of the littoral currents, which set sooner into Hendon bay, than at the mouth of the harbour, in consequence of the tidal wave having a more rapid progress in the deep water of the offing, than along the shallow water of the coast. In consequence of this, there was a counter-current northwards from Hendon bay, and similar counter-currents existed both north and south of the mouth of the harbour, caused by the projection of the piers. A point had been observed between the northern and southern groynes, where there was a junction of these tidal currents, indicated by a spit of sand and gravel.

Until Hendon bay was reclaimed and converted into dry land, this heaping up of the *debris* would occur, on the southern side of the south groynes, and the in-draught of tide into the mouth of the harbour would produce a like effect on the northern side of the north groynes. The construction of the intermediate groynes had been delayed by want of funds, but there was little doubt of a uniform and permanent line of shore being formed when they were run out.

The coffer-dam in the tide-way of the river, enclosed 2½ acres within it; there was considerable difficulty in obtaining a secure footing for the main piles, but after a deposit of clay had been made, the object was effected, and being secured together by walings and bolts the dam proved quite water-tight. A series of raking shores inside gave great solidity to the structure, and enabled the rock to be excavated close up to the inner piles.

The sea coffer-dams of the channel were, however, of a different construction; the object being to protect the inner dam by another in front of it, in skeleton, secured by a deposit of clay brought up to the low

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water-mark. The inner dam had then a mass of clay deposited on the interior side, having a tendency to force it outwards, but this effect was prevented by a series of raking shores. This pressure had the desired effect of keeping all in place, although powerfully acted upon by the waves of the sea. On more than one occasion it had been found necessary during raging storms, to add extra weight to the dam, by bringing wagons heavily loaded with rubble stone, along the railway, to the centre part. The effect of this additional weight was to impart greater stability to the structure, even when the waves were lashing against the timbers with considerable violence.

The average cost of the three channel coffer-dams for timber, iron, and labour in fixing and for depositing the clay, amounted to 19*l.* 3*s.* per lineal yard; and deducting from that sum the value of the timber which had been used in other portions of the work, the actual cost had been 16*l.* 12*s.* per lineal yard of coffer-dam exclusive of the expense of rooting out the timbers and removing the clay. When compared with coffer-dams of the usual construction, even in situations not exposed, as these were to the action of the sea, the cost was very moderate.

The scouring conduits were supplied by water from the half-tide basin, through archways into a well 40 feet long, on each side of the shipping entrance. The four entering ports from each well were closed by shuttles, having the cills all laid at one level of 23 feet below the datum, or 8 ft. 6 in. under low-water of ordinary spring tides.

Each entrance was 7 feet wide by 9 feet high, and the conduits were separated into two, for a short distance within the discharging ports.

	Under low water of spring tides. ft.	in.
The first pair adjacent to, and on either side of the shipping entrance, had their bottoms laid at the depth of	12	0
The second pair beyond on each side	9	4
The third pair	7	4
The fourth pair	5	4

The sectional areas of the last-mentioned pairs were about 10 per cent. less than the sectional area of the entering ports, being each ..... 7 ft. 0 in. wide by 4 ft. high.

The sectional areas of the first-mentioned pairs were about 20 per cent. less than the entering ports, being each ..... 6 ft. 9 in. wide by 4 ft. high.

The sectional areas of the intermediate pairs were proportioned in like manner, with the intention of keeping up the force of the currents, and on plan the conduits had the form of a fan, for the purpose of conducting the issuing water into the centre of the channel.

The area of the great dock with the southern half-tide basin, was taken at 34 acres = 1,481,040 superficial feet.

The scouring water at an ordinary spring tide, might be lowered to the permanent level in the dock, being a depth of 4 ft. 6 in.

Hence, 1,481,040 × 4·5 = 6,664,680 cubic feet of water available for scouring.

Eight apertures, each 7 feet wide by 9 feet high ..... = 504 sq. ft.
Deduct 10 per cent. for friction through the conduits ..... = 50 ,,

Gave as available area for scouring water ..... = 454 sq. ft.

	Ft.	In.
Then the rise of an ordinary spring tide ... =	14	6
Deduct for rise of tail-water ..... =	1	0
	13	6
The mean depth 4 ft. 6 in. ÷ 2 ..... =	2	3
Leaving mean pressure ..... =	11	3

which was calculated to produce a velocity of 862·44 feet per minute.

Then 862·44 × 454 = 391,548 cubic feet per minute,

and $\frac{6,664,680}{391,548}$ = 17 minutes

2 minutes consumed in opening the shuttles.

Leaving 15 minutes available time for scouring.

Assuming $\frac{6,664,680}{15}$ = 444,312 cubic feet per minute, which passing through the sectional area of the channel on the inner side of the pier heads = 1232 square feet,

$$\frac{444,312}{1232} = 360 \text{ feet per minute,}$$

= 4·091 miles per hour for the mean current,
= 3·166 miles per hour along the bottom,

which was a current capable of carrying along large shingle and broken stones.

The effect of an experimental trial had been most conclusive. Although a large quantity of clay remained in the channel of the outer coffer-dam, standing at the height of 6 feet above the bottom, and consequently holding the water within it in a quiescent state, yet when the shuttles were drawn, although there was a depth of 16 feet of water in the channel, or 4 feet above low water of spring tides, and the pressure of the water in the docks only 10 feet, and when closed was reduced to 7 feet, the column of issuing water caused that in the channel to be heaped up, and being prevented by the channel cut through the marly rock from escaping laterally, the whole mass of fluid was set in motion like a river. Meeting with the resistance of the clay in the outer coffer-dam it rose and fell over it, as a tumbling bay; and even then the course to seaward was strongly visible on the surface, for a distance of more than 2000 feet beyond the pier-heads.

It was stated that Mr. Murray might be congratulated on having carried out a system of sluicing, which promised to be useful in important cases. Now that the size of vessels was so much increasing, the maintenance of deep entrances to harbours and docks became a question of the greatest interest. It was argued that a marked distinction should be drawn between the operation ordinarily mis-called sluicing, or scouring, and the much more effective principle applied in this case. In the former, the object was to direct a small stream of water, with a high velocity, directly upon the spot to be scoured, and though usually effective in removing deposit from one particular place, it only carried it a short distance away to be soon again deposited; and hence, as at Dover and many other places this system of scouring had, from its inefficiency, fallen into disrepute. The process, however, adopted at Sunderland, was on a different principle, namely, to create what might be called a temporary artificial river, which running in a well-defined channel for a certain time at low water, should not only scour or clear the bed of such channel from deposit, but should carry that deposit away to a considerable distance. The velocity with which this scouring stream should run could be perfectly regulated by the sluices, the only object of which became, in this case, to supply such a quantity of water into the channel as would impart and maintain the velocity acquired; they, therefore, should be so placed as to distribute the supply widely, and thus to insure an equable stream in the channel. It was considered important that the channel should become gradually narrower towards the mouth, so that the stream might act with the greatest power on the part where the deposit was most likely to occur. Confident expectations were held out that by the more general application, under suitable regulations, of this system of sluicing, deep entrances might be efficiently and economically maintained in situations where they would otherwise have been impracticable.

It was very desirable, in the discussion of the subject, to avoid confusion of terms, which so often led to apparent diversity of opinions, on the part of those who ought to agree upon such a question as that of the well-known effects of a scour of water. Unfortunately, the terms "sluicing" and "scouring" had been indiscriminately applied to the operation of merely stirring up and producing a commotion in a body of water at any one place, by the violent action of a jet of water directed on a limited surface, and the operation of a regular continuous stream, capable of holding in suspension and carrying away the matter set in motion by it. The former was a very common application of water-power in English work, the latter had not, hitherto, been applied so frequently as on the continent.

The effects were totally different and ought not to be confounded; a violent jet of water applied to one spot was useless as a scour, unless the quantity of water ejected was sufficient to produce a regular current over the bottom surface, or within the channel to be scoured, and was also sufficient to take up and to sweep away the deposits on that bottom surface.

A very moderate current would suffice to produce this effect in nearly all those cases in which engineers would be most interested; a velocity of two or three miles per hour would remove coarse gravel, and even less was sufficient to carry away any deposit consisting of finer particles, but in such a case the current must be as uniform as possible.

An average velocity would not suffice if it was an average of a violent commotion at one part, and a low velocity at others; this might even be and generally was mischievous, instead of beneficial, and such an action must not be called "scouring," it was merely stirring up, and from this confusion of terms there no doubt arose those contradictory opinions, as to the probable effects of various proposed works which were called, without distinction, "scouring" or "sluicing."

Where a sufficient quantity of water was caused to flow through a defined channel, as had been proposed by Mr. Rendel, at Birkenhead, or as had been so judiciously adopted by Mr. Murray at Sunderland, the effect must be such as had been described in the paper; and it was very gratifying to see the well-known action, observed in natural channels, such as rivers which maintained their own uniform depth, so successfully imitated in artificial works.

It might also be observed in natural outlets, or by small experimental apparatus, that a column of water discharged with a uniform and moderate velocity into an open basin continued its course in a direct line, and produced a scour to a much greater distance than the same quantity of water would do, when tumbling in or boiling out from an aperture, and producing a great local commotion, the power of which was soon dispersed, and was therefore expended without producing that effect which was generally desired. A long channel might be thus cleared, and the effects carried out some distance into the larger basin, whether of a river

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or the sea; while a short channel, immediately acted upon by sluices, would not be so effectually cleansed and no effect would be produced beyond the mouth. The great object should be to obtain a uniform velocity over the whole sectional area of the channel, the arrangements made by Mr. Murray appeared admirably adapted to insure this, and the results he had described confirmed the opinion.

The peculiar quality of the magnesian limestone excavated was commented upon, it was almost as soft as chalk whilst *in situ*, but hardened very rapidly on exposure to the air; it stood almost vertically in the excavations and greatly facilitated the execution of the works.

This was nearly, if not quite, the first time that a harbour had been constructed with the intention of eluding an existing bar at the mouth of the river which was the natural outlet, and it was a principle which, where practicable, would be advantageously followed by engineers instead of incurring the expense of improving the outfall of the rivers and keeping the mouths open by dredging. The systems of scouring at the harbours of Dunkerque, Ostende, and Boulogne, were mentioned, and succinctly explained. The effect there obtained was to render available, for good sized vessels, ports which otherwise would soon be entirely blocked up, like the former harbour of Ambleteuse, where a fishing boat could now scarcely enter. The object to be attained by sluicing was not only to scour away the deposit in the channel, or entrance to the harbour, but to prevent a bar being formed by the accumulation of that deposit, at a short distance from the mouth of the harbour; this could only be effected by setting simultaneously in motion, and keeping up the velocity of a large body of water, which would carry the deposit far out to the sea depths. The sluices at Boulogne, constructed by Vauban, not being sufficiently large did not efficiently perform this duty, and hence the necessity for such long piers for the entrance, and for the further extension of them, now very wisely contemplated, to meet the demands of the traffic through that port.

It was urged, that one view of the case, not hitherto brought forward, was the manner of introducing the deposit which was required to be removed. Now, water entering a harbour, into which there was not any considerable indraught, had not any great velocity, and the amount of matter carried in was only that due to that particular velocity. If a greater velocity was imparted to the outpouring than the ingoing stream, any material so brought in would be partially carried out again by the ebb-tide, and the rest would be cleared away by the action of sluicing. Always provided, that a uniform velocity was imparted to the entire mass of water in the channel, which could only be done by arrangements somewhat similar to those described in the Paper.

If water was projected downwards at an angle it was reflected, and the momentum was lost on the bottom; if it could be discharged through sluices of the same section as the harbour itself, and at the same velocity as it was required to travel throughout the distance, a uniform velocity would be obtained; but as this was not practicable, advantage must be taken of the equality of pressure: and to insure this at the extreme point, the orifices might be made narrower, so that the pressure, as applied from the sluices, would be brought to bear, and would cause the whole mass of water to move at one uniform velocity in the channel.

With reference to the utter failure of action of water, when projected at an angle, it must be borne in mind that fluids followed the same law as solids, as regarded rectilinear motion; any rectilinear motion given to the whole mass would be preserved, and thus the beneficial effect of a uniform scour in removing on the efflux, or outdraught, whatever deposit had been brought in on the influx, or indraught, at a less velocity, would be secured.

It was agreed that it would be advantageous, if possible, to select, as sites for harbours, positions where there was neither littoral travel of shingle, nor deposit of silt or sand: but where were such positions to be found? Exception was taken as to the statement of the deposit occurring on the slow indraught of the flood tide, and being washed out again by the scour when practised on the ebb-tide. That condition would apply to Birkenhead, but not at all to Dover. The travel of the shingle might be stopped for a time by groynes or piers, but it was only a matter of time, and when the depths into which the shingle had been directed were filled up, the former state of things would be again observed.

It would appear that the groynes at Sunderland had been placed and constructed with great judgment, as the accretion of land had been steady and permanent. The time, however, would arrive when, having done their work, they would cause the sluicing power to be necessarily called into play, to prevent the formation of a bar beyond the piers, unless there was a greath depth of water at that spot.

The travel of shingle was due to the action of winds and tides, and would continue under any circumstances, although the direction of the travel might be changed for a time by artificial barriers.

The great problem in sluicing was the maintenance of a strong uniform current; the sluice apertures must necessarily be under pressure, and the issue of water must be so contrived as not to tear up the bottom, whilst the power so brought to bear against the tail-water must be such as to set it all in motion in a mass, imparting a sufficient velocity to it to carry away all deposit and convey it far out to sea. For this end the various heights of the cills of the sluices at Sunderland were well intended, as all parts of the mass of water were acted upon simultaneously and pressed onwards in a mass, instead of allowing the upper stratum of water to curl back, as was the case when the cills were all at the lowest depth.

Sympathy was expressed for the anxiety naturally felt by the author of the Paper, when trying such interesting experiments as the novel constructions exhibited in the Sunderland Docks; several equally novel constructions had been tried at the Victoria (London) docks, of which a full description was promised to the Institution; with the details of all the casualties occurring, and which were admitted to be incidental to all great works, especially when they involved novelty of design.

In closing the discussion for the evening, the Author was again complimented for the interesting character of his Paper; and a hope was reiterated that all the casualties and accidents would be noticed in revising the Paper; as nothing was so instructive to the younger members of the profession as records of accidents in large works, and of the means used in repairing the damage. A faithful record of accidents, and of the means by which the consequences were met, was really more valuable than a description of the most successful works. The older engineers derived their most useful stores of experience from the observations of the accidents occurring to their own and other works, and it was most important to record all such experience in the archives of the Institution.

THE SCUTARI MONUMENT AND PEACE TROPHY.

On the 9th May last, the Scutari Monument and Peace Trophy were inaugurated at the Crystal Palace, Sydenham, upon which occasion the Queen, Prince Albert, and a large number of the *elite* of the land, were present. In reference to these two works of art, which formed the most prominent objects of attraction, we may remark that the former only was in a finished state, according to the original design; and it may be considered in every way satisfactory and appropriate, at least as far as symbolic sculpture is concerned. The Peace Trophy, being much more elaborate in its details, it was found to be impossible, despite the most strenuous exertions of Mr. Hayes and his assistants, to get completed in time; but, notwithstanding, quite sufficient was accomplished to show what the design would be when completely carried out. The Scutari Monument is erected in the nave of the palace, on the southern side of the centre transept, and consists of an obelisk nearly 100 feet high, surmounted by a Greek cross in gold, the base being an imposing square pedestal, at each corner of which is represented a mourning angel of colossal size; the treatment is both original and highly appropriate. As a whole, and as a sample of monumental sculpture, this production of Baron Marochetti may safely be pronounced a great work, distinguished by that simple grandeur and solemnity which should ever characterise such subjects. In the centre above the figures, the royal arms of England are sculptured, flanked on each side by palm branches; and on one side of the pedestal between the statues is the following inscription:—"Here lie buried soldiers and officers who fell in the defence of Turkey, in the years 1854, 1855, and 1856, in the reign of Queen Victoria. Erected 1856." The monument is to be executed entirely of grey granite, and is now in process of erection at Scutari.

The sketch for the design of the "Peace Trophy" is also by Baron Marochetti, but is not quite so successful as that of the monument. It is an attempt to produce statuary resembling metal, the architectural portions being in imitation of marble, and the decorative parts gilded. The artist in the conception of his design appears to have based his ideas on the formation of some of the ancient Roman candelabra, which are worked out full size as far as they have gone, very successfully; but as the work is in an unfinished state, it is not fairly open to critical remark. On the summit of what may be termed this colossal candelabrum is placed a female statue emblematic of Peace, 20 feet in height, clad in gold and silver tissues, holding in her hand an olive branch. The design of the Trophy is divided horizontally into three stages, the base being square, the next octagonal, and the third, on which the statue is placed, being circular. The octagonal portion is pierced on its eight sides by niches, in which are intended to be placed figures of Minerva, Urania, &c., the flesh portions of which are coloured in imitation of solid bronze, and the draperies dead gold, producing novel and highly effective results. In the absence of numerous enrichments originally intended, but not yet completed, the Trophy is embellished with festoons of leafage and flowers, which give it a gay and showy effect, in forcible contrast with the solemnity of the Scutari Monument that stands immediately opposite.

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ANTIQUARIAN DISCOVERIES AT COVENTRY.

Few places in England can now boast such a number and variety of architectural relics as Coventry, pre-eminently "the city of spires!" Two of the steeples which have thus gained distinction from their unusual loftiness and beauty of proportion, are situated within a hundred yards of each other, and in still closer proximity once stood a glorious cathedral; which, being built on a similar plan to that of Lichfield, had a central and two western towers. The combined effect of these three buildings, when viewed at a proper distance especially, will be readily imagined to have been wonderfully sublime. But the cathedral has been long since levelled, with the exception of some 30 feet of one of its towers, and the surface built on or otherwise appropriated. A few weeks since, however, in digging near the "Priory Row," some of its massive foundations were disclosed, consisting of the lower part of the south-western tower. Subsequent excavations have revealed the line of the west front almost perfect, also the plinth and base mouldings to the exterior, which are of early date, and unusually deep and bold, also some of the respond piers to cross arches within, which show the walls to have been full 6 feet thick. This west front thus, it is evident, measured as much as 130 feet in length. Beyond the north-west tower has also been found a portion of—apparently a crypt, it being constructed on a lower level. A slight historical sketch, so far as it can be ascertained, will be acceptable.

When Camden the historian visited Coventry, he says,—"The city is conveniently placed, large and neat, defended with strong walls, and adorned with very handsome buildings, among which are two churches of rare workmanship. The city has nothing very ancient about it except the monastery or priory, whose ruins I saw near those churches." It was founded by king Canute for nuns, who being soon after turned out, Leofric, earl of Mercia, A.D. 1040, enlarged and in a manner rebuilt it, with such profusion of gold and silver that the walls of the church seemed too confined to contain the treasures, which struck all beholders with astonishment; no less than fifty marks of silver being scraped off one single beam. It also contained numerous religious relics, which were held in the greatest veneration by the devotees. He endowed it with such revenues that Robert de Lindsey, bishop of Lichfield and Coventry, transferred the episcopal see hither; but this see a few years afterwards returned to Lichfield, yet so as that the same bishop is styled bishop of Coventry and Lichfield.

This noble cathedral was levelled to the ground by Henry VIII. at the time he destroyed the neighbouring monasteries, after it had stood nearly 500 years. In Dugdale's plan of Coventry, by Hollar, the space occupied by the cathedral and priory is a blank down to the river Sherborne and to Mill-lane, except a part of the cathedral ruins, reaching from about the north transept to the bishop's palace. The spot was afterwards converted into garden ground, but it is probable that several apartments might even now be discovered buried in the earth. Tanner says: "The cathedral and the monastic buildings are all gone, except the lower part of the western towers, from which some idea of the grandeur of the western front may be formed." The bishop's palace only retains the name, and was sold in 1647 to Samuel Lacey and others.

A part of the site of the ancient cathedral was again consecrated in 1776, and is now used as a burial-ground for Trinity parish. In June 1825, upon under-building a house at Hill-top, the ground was opened to a depth of 14 feet, when the south front wall of the cathedral, probably the transept, was discovered in perfect condition; the mouldings of the plinth, large and bold, commenced about 12 feet from the present surface, above which was the upright facing of the wall continued about 7 feet, its thickness being about 3 feet. The great central tower was standing in 1576, though despoiled of its steeple. A fine groined stone crypt and vault (which has been used for a century or more as wine and liquor vaults) commences under the eastern end of the cathedral, and runs as far as the transept; it is said to be as much as 220 feet long and 15 feet wide.

Several kings, queens, and princesses have visited this famous priory at various times, and taken up their abode there, it having extensive accommodation, and extending, with its offices, fish-ponds, &c., backward from the cathedral to the Sherborne. The sites of the different edifices are recognised by the naming of the streets by which they have been replaced.

REVIEWS

Handbook of the Arts of the Middle Ages and Renaissance, as applied to the Decoration of Furniture, Arms, Jewels, &c. Translated from the French of M. Jules Labarte. London: Murray. 1855. 8vo.

The zeal with which the study of mediæval art has been pursued of late years has not been confined to England. In France and Germany many important restorations of ancient edifices, and many learned investigations of the principles of their architecture and decoration, attest a sympathy with the spirit in which the works of our ancestors are now studied in this country. The ages which produced the cathedrals of Lincoln, Canterbury, Cologne, and Amiens, are not often called the *dark* ages now, either in England or on the Continent.

Yet abroad, the study of mediæval art appears to us to have been pursued with infinitely less earnestness and success than at home. In saying this, we do not forget the great works carried on at Cologne; but we do also remember the cast-iron spire of the cathedral of Rouen, the atrocious mutilations of the monuments of St. Denis, the vaulting of Notre Dame of Paris painted with the *insignia* of Louis Napoleon, and the theatrical effect which is almost invariably given to ecclesiastical restorations on the Continent.

We must not, however, speak too vauntingly of our superiority in these particulars. For one new church of really good Pointed architecture, how many most vile travesties of it has this age produced in England! Yet, surely the condition of architecture is worse abroad. It is difficult to find any churches on the Continent, of modern design, in which the very grammar of Christian art is not grossly violated.

It is easy, as it appears to us, to account for the comparative lack of success in the study of mediæval art out of England. The great principle of that art, which distinguishes it from the styles which superseded it, is *stern, uncompromising truth*. From the Cinquecento style down to the latest plaster glories of Belgravia, the builder's skill consisted in lying, shameless and incessant—in continually and loudly proclaiming the thing that is not with respect to his works—in bedizening them with plaster and paint, as a harlot plasters and paints her face, to hide the sores and rottenness within. This system of deception, which was not merely without shame, but impudently demanded applause for its cleverness, superseded the mediæval styles, which, whatever their relative excellences and defects, had at least this merit in common—that they told the truth. In the humble hamlet chapelry, and in the glorious archiepiscopal cathedral alike, the fundamental principle was maintained in architecture of honestly avowing its means. In that architecture there was no false shame that hid the poverty of materials and the exigencies of construction, or falser pride which disguised them. Did the pressure of an arch require a slanting prop for its support—that support was placed undisguisedly where it was wanted. Was the stability of pillars threatened by excess of superincumbent weight—a tie-beam was boldly thrown across to connect them. Were more windows required for light and air on one side of a building than the other—the windows were put where they were wanted, without any corresponding blank windows being placed opposite them from an idiotic affectation of regularity. So it was also in smaller matters. In a piece of joinery—a church-chair or a choir-stall—if a peg were wanted to bolt two pieces of wood together, the peg was put in its place plainly, and no pains were taken to keep it out of sight. Were cords and poles required to support hangings—they were placed in their proper position quite visibly, and no tricks of the upholsterer were used to hide them.

How different all this is from modern work we know well enough. The mediæval architect wanted to exalt his work—the modern builder is ambitious to exalt himself. The former sought no record of his name—to the latter newspaper praise is almost the *summum bonum*. The former loved the church he reared, or the decoration which he wrought; he was very anxious that they should remain to be the joy and admiration of future ages; and, if you would please him most, you would cheer his toil by the thought that long after the brain which devised and the skilful arm which executed were dust, succeeding generations should view his works reverently, and be better for the sight of them. We now are principally anxious to "get on" in this world, and so that our architecture last our day, and help us to fame and wealth, we have little heed for the after-fate of our

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works. This is not the way to achieve anything really great; no great work can be produced without humility and self-abnegation and earnest love of the work itself.

The silly affectation of tawdry display, and the utter irreverence of the glorious achievements of the mediæval architects, which have disgraced modern art, have been more glaringly exhibited on the Continent than in England. It is a great mistake to suppose that, because we have had a Reformation, Catholic art has been more degraded in England than in Roman Catholic countries. We believe that the degradation into which that art has fallen in those countries could hardly have been lower. Any one accustomed to wander about ancient foreign cities, must be familiar with instances of noble churches mutilated with almost inconceivable barbarity, or prostituted to vile secular uses. Even in minor matters of ornament, the ignorance of right principles is greater abroad than here. As a general rule, the vestments of Roman Catholic priests, the tawdry finery of their altars, and the furniture of their churches, show far worse taste than is common in the *Instrumenta Ecclesiastica* of England, or at least in the better specimens of them.

The French are continually said to have better taste than the English, and it cannot be denied that in millinery and upholstery they have. Without question they dress better than we; without doubt their shopkeepers set out their windows more jauntily than ours. Their pageants are more effective, their masquerades gayer, and they can make much more of tinsel and coloured lamps than we can. If the English attempt a masquerade, it is dismally indecent; if they have a pageant, it is ridiculous. There are in the national character a dignity and earnestness which prevent the people from readily lending themselves to a mock solemnity, such as the unveiling of a pasteboard monument at Sydenham. And it is to these national characteristics that we mainly attribute the more effectual revival of Christian art in England; the sterling honesty, manliness, and truthfulness of the people are the best guarantees that an honest, manly, and true taste in architecture will be permanently established in this country.

We have been led to these reflections by the perusal of a work the title of which precedes this article, and which, as we suppose from the preface is the translation by an English lady of the descriptive catalogue of a private French museum. Such a work is hardly entitled to be called a 'Handbook of the Arts of the Middle Ages and Rennaissance.' The contents of a musuem are, of course, in a great measure collected fortuitously, and a catalogue of them cannot have the completeness and method which should belong to the handbook of any art. The defects of the work in this particular have, however, been somewhat supplied by resort on the part of the translator to several English authorities; and on the whole the work, if not entirely satisfactory, may be very usefully referred to as a repertory of much curious erudition and knowledge of mediæval decoration.

The Churches of Essex. By GEORGE BUCKLER, Architect. Part I. Royal 8vo. pp. 32. London: Bell and Daldy. 1856.

In this Part we have the parish churches of Margaretting and Broomfield, both in the Hundred of Chelmsford. Viewing the work as an architectural one, it is not at all up to the mark. The author tells us that the church of Margaretting is a noble example of the Early Perpendicular style. If so, it surely demanded to be better illustrated in these days than by a crumbly, coarsely-executed perspective of the north porch—a cut of a crowned capital, only remarkable for its quaintness—an outline of the font, and a simple ground-plan. Looking to the description of the edifice, which is full, we find there is a "grand wooden tower," an "east window with beautiful tracery," "stone arches opening into the aisle," springing "from clustered columns with richly moulded capitals and bases;" an elegant window in the east wall, and an "elegantly proportioned door" to the west, with "scientific carpentry connected with the spire." There being these parts so worthy of superlative description, it might have been well to have had them pictorially in the work, for one plate ably given, of well selected subjects, would have been worth more to the student than pages of description, that cannot show design or the science used in construction. To Broomfield church, the remaining portion of this Part, the foregoing remarks may be also applied; for notwithstanding there is a fine, double-light Decorated window, a fine piece of carved tracery, a very early wreathed hand-rail to the belfry stairs, which are of curious construction and worthy of examination, and a fine specimen of a triple-light Perpendicular window,—yet we see them not. But instead of these praiseworthy details, we have some given that are scarcely worthy of being represented. If Mr. Buckler wishes his book to take a place among those works that architects and antiquaries consult, he must not only point out what is good, but show us the excellences that are fit to be looked at and followed. Appended to the architectural descriptions, there are historical notices, giving the origin of the place, the manors within the parish, its extent, the number of houses and population; with accounts of the families that have possessed from early times the manorial estates, of much interest and value.

The printing of the work is excellent, as all Mr. Whittingham's productions are, and if the author will give more attention to the selection of his illustrations, we think his work will receive extensive support.

A Supplement to the Encyclopædia of Civil Engineering. By EDWARD CRESY. London: Longman. 1856.

A supplement to Mr. Cresy's large and extremely valuable 'Encyclopædia of Engineering,' has recently been published, for the purpose of noticing some of the improvements in construction that have been made since the work itself first appeared. Most of our readers are, no doubt, well acquainted with this compendium of what is important and interesting in the sciences of engineering and architecture; but, for the advantage of those who may not have seen it, we take the opportunity, which the publication of the Supplement affords, of calling attention to the work.

In its form, the 'Encyclopædia of Engineering' is a ponderous volume, comprising nearly 1800 pages of closely printed matter, and illustrated by upwards of 3000 engravings on wood, executed in the first style of the art. There is no alphabetical arrangement adhered to, but the subjects are classed according to their bearing on each other. The first, and perhaps most interesting portion, comprises the history of civil engineering, commencing with the earliest periods, and proceeding to describe and illustrate the most celebrated engineering works that have been constructed in Europe and America to the present time. Harbours, docks, canals, breakwaters, lighthouses, railways, tunnels, bridges, roads, public buildings—every work, in short, ancient or modern, that is worthy of note, either from its magnitude or from peculiarity of construction, has a place in this history of civil engineering, which would of itself occupy a very large volume, if printed in type of the ordinary size. The second and larger portion of the work treats of the theory and practice of engineering, commencing very properly with the consideration of the materials used in construction, and the geological phenomena which have a practical bearing on the operations of civil engineers and architects, whether as regards the foundations whereon to build, the slope of cuttings and embankments, or the formation of tunnels. Proceeding from the materials, to the manner of employing them, attention is first directed to the science of geometry, and the methods of ascertaining by trigonometry and levelling the correct relative positions and the contour of any given surface of country. This leads to the art of surveying, the valuation of property and of artificers' work in general. Separate chapters are devoted to mechanics, to machines, to carriages of various kinds, piles and pile-driving, mechanical agents, hydrostatics, fluids in motion, the water-supply to towns, the atmosphere as a moving power, warming and lighting, steam as a moving power, timber and its properties, timber bridges, masonry, stone bridges, the construction of jetties and sea-walls, canals, draining and embanking, the construction of machinery railroads, and the principles of proportion in relation to architecture. All these matters are treated in a sound practical manner, and are profusely illustrated, so as to give a clear insight of the various subjects, which are entered into more fully than might be supposed possible in a general treatise. To the engineering student the work is most valuable, and there is no engineer or architect to whom it will not prove useful as a work of reference.

The Supplement that has just been added to this encyclopædia, with the view of bringing it to the present advanced state of knowledge, comprises, in the first place, the subject of water-supply, including the different plans that have recently been proposed and adopted for improving the water-supply of London. Intimately connected with the supply of water is the drainage of

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large towns; and the Supplement contains calculations and remarks on the plans recently proposed for a combined system of drainage independent of the Thames. The present aspect of railways is next considered, and the subjects of cubical proportion, and of brick and iron construction, including the Crystal Palace, iron piles, cranes for hoisting, the Britannia and Conway tubular bridges, and the suspension bridge across Niagara river, constitute the remaining portions of the Supplement, which notices all the material improvements that have been introduced since the first edition was published, and the most important modern constructions. We cannot too strongly recommend the 'Encyclopædia' in its present completed form, to the attention of those of our readers who do not possess it. As a sample of the work, we make the following extract from that portion of the Supplement which treats of brick and iron constructions:—

"When cast-iron girders of large dimensions are required, it is important to notice that in cooling a very irregular contraction takes place, often creating a strain in some parts of the metal, producing fracture. This contraction is more equal when the form of the girder in its section exhibits uniformity of thickness throughout its several parts; in a T shape, the arms constituting it, if made of one width, will have less tendency to an unequal cooling, and consequently a greater dependence upon its strength. Another caution for the founder is, that the angles should be rounded off, and not left too sharp or rectilinear. The builder will find that the same weight of metal applied to several small castings, will be of equal strength, and more to be depended upon than one large girder, which is also more difficult to move, and to secure in its place, than a number. The tensile strength of cast-iron having been considered as equal to 6½ tons per square inch, we may use that calculation to proportion any beams, and make them of a size that the builder may depend upon their strength and be able to move them into the places destined, without the labour required for hoisting at one time a very considerable weight, not always practicable where a small number of workmen are engaged; and similar weights may be also more equally distributed over the walls that are to carry them.

"Wrought iron being crushed when 16 tons are applied to each square inch, this weight should not be hazarded upon a column of any height. The heights of columns must be made proportionate; for we find that their strength varies inversely as the square of their length. Square columns have their strength as the fourth powers of their diameters, their breaking weights being proportional to their width and to the cube of their thickness directly, and to the square of their length inversely. Where the metals are preferred for construction to timber on account of its inflammability, the cost is perhaps not so much taken into account; but the power of Baltic timber to resist a strain is greater than is usually supposed. Rods of that material will bear a tensile strain of five tons per square inch; the tension rod of wrought-iron of the same strength, would be one-fourth only of its sectional area, but nearly three times its weight; wrought-iron will bear a strain of 10 tons per square inch, and Baltic timber one-fourth only of that weight.

"The cylindrical rod of wrought-iron an inch in diameter, and weighing about 8 lb. per yard, will bear tensilely 16 tons. To serve the purposes of calculation, the square of the diameter, taken in ¼-inches, is the breaking weight in tons, and half this quantity is the weight in pounds per yard; as a rod 6 inches in diameter contains 24 ¼-inches, that number squared gives 574 tons for the breaking weight, one-third of which should be allowed in practice.

"A layer of concrete, with a surface of asphalte, forms a secure floor, and fire-proof."

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1. *Repertory of the Technical Literature comprising the years* 1823 *to* 1853, *inclusive*. By Dr. SCHUBARTH. Published by order of the Ministry of Commerce, Trades, and Public Works. Berlin. 1856.
2. *The Literature of Architecture and Engineering during the last Thirty Years, being an Index of the Chief Works in the French, English, German, Italian, Dutch, and other Languages, relating to those Sciences*. By A. MALBERG. Berlin: Ernst and Korn. 1852.

The importance of the former work will be best understood by the statement that it is the product of thirty years' labour, and that it contains about 50,000 articles or titles of all papers, essays, or descriptions relating to technology, and published in the different magazines, reviews, journals, collections, &c., of all nations. The said 'Repertory' embraces the whole literature of the technological department, extending to mechanics, architecture, navigation, agriculture, mining, and the more important branches of physics, natural philosophy, and chemistry, as far as they relate to industry; and ranged according to the different trades, sciences, machines, instruments, and products. In short, the present work is indispensable to those who wish to effect a deep investigation of any given subject relating to industry and its progress. As a first-rate book of reference, it is worthy to stand on the shelves of every public or private library. It may be observed that, through the indefatigable exertions of Mr. Woodcroft, the superintendent of the specifications at the Great Seal Patent Office, to render that department of the public service worthy of the nation, Schubarth's 'Repertory' has already found its way to the library of the Patent Office, where it may be consulted by the student and those inventors who are anxious to ascertain their claims to priority. It may, moreover, be added, that Mr. Woodcroft has just published an English translation and alphabetical arrangement of the subject-matter index of the said work, to serve as a key to the English reader with reference to the subject-matter indices published by the Commissioners of Patents previous to the year 1855, and pointing out the inventions patented in England during a period of 238 years. Such an undertaking speaks for itself.

The second-named work, though less extensive, still musters about 3000 titles of works published in Germany and other countries, from 1820 to 1850, on matters relating to architecture and engineering. The chief divisions are:—Descriptive geometry; geodesy; mechanics; technology, with reference to mechanics and chemistry; history and archæology of architecture; monuments of architecture; architectonic ornaments; architectural works and plans of modern times; rustic architecture; hydrography; construction of roads and bridges; railways and telegraphs; machines; ship-building. An appendix contains a list of the chief technical periodicals in the above languages. This little and not expensive book will be found very valuable by both the student and general reader. Like the former, it may be consulted at the library of the Great Seal Patent Office.

NOTES OF THE MONTH.

Since the publication by the *Times*, of the powerful article on the decoration of the new Reading-room at the British Museum, which we have quoted in full at page 195 of our *Journal*, we understand it has been determined by the government to carry out the suggestions so well advocated by our cotemporary.

The erection of a church in connection with the establishment in the West End Park, Glasgow, is decided on. The style is the early Lancet Pointed, and the structure will be formed of the finest and most durable white polished freestone. The building, externally, is about 130 feet in length, by about 70 in width, with a nave and aisles similar to those of the cathedral. The front elevation of the church is designed in broad and massive lines. The campanile tower, in which is the principal entrance, is attached to the north-east corner of the building. The square of the tower is not less than 25 feet up through the entire height of 150 feet. The interior is no less imposing. The lofty ceiling of the nave, which rises to an altitude of upwards of 65 feet, will be a most superb and majestic piece of open roof carpentry. The church is seated to accommodate from 1000 to 1100 sitters. The plans have been prepared by Mr. J. T. Rochead. The cost will be about 8000*l*.

An association has been organised in Liverpool, for the improvement of the dwellings of the industrious classes. It is called the "Liverpool Labourers' Dwellings Company." A plot of land has been purchased in Northumberland-street, Toxteth Park.

In Whitnash church, Warwickshire, some stained-glass windows have been recently fixed by Mr. Holland, of St. John's, Warwick. The east chancel window contains three subjects,—the "Baptism," "Last Supper," and "Ascension;" with canopies and daisy border, emblematical of St. Margaret, to whom the church is dedicated. The tracery is filled with angels, in an attitude of prayer. A side window contains the following subjects in panels:—"Christ Blessing Little Children," "Timothy being taught the Scriptures," "Lamb and Banner, and Dove Descending."

A stained-glass memorial window has also been fixed by Mr. Holland in Southam church, Warwickshire, containing the following subjects:—"The Ascension, and Acts of Mercy;" "Christ Healing the Sick;" "Almsgiving, or Relieving the Pilgrim," illustrating the text—"I was hungry, and ye gave me meat; I was thirsty, and ye gave me drink; I was a stranger, and ye took me in."

The Reading Board of Health have appointed Mr. Marshall, of Westminster, to be their Surveyor and Inspector of Nuisances.

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At the Surrey Zoological Gardens is now being constructed a large music-hall, 165 feet long by 99 feet wide, capable of accommodating an orchestra of 200 performers. The walls of the building are of brick, and the roof, which is semicircular, is of wood, formed by laminated ribs of Memel boards. Mr. Danson, the eminent scene-painter, and numerous assistants are also actively engaged in producing a very large view of Constantinople, and some minor works, which will have a fine effect when viewed from the galleries constructed in front of the new music-hall, which faces the lake, on the margin of which the fire-works are intended to be exhibited.

Among the caterers for the amusement of the public, none stand more deservedly prominent than the respected proprietor of Cremorne-gardens, who, year after year, has made such efforts to delight the thousands who flock to this delightful place of resort. This year Mr. Simpson seems to be out-Heroding-Herod in his exertions, and has now in progress an immense structure called the Ashburnham Pavilion, being constructed of wood, keyed together with iron bolts, and covered with American canvass, which is perfectly water-tight. If we may be allowed the simile, this building is arranged cathedral-fashion, viz., with a nave in the centre and an aisle on each side; its length is 360 feet, and its width 100 feet. There is no glass employed in this somewhat novel erection, the light being admitted by 201 rectangular-shaped windows arranged as transparencies the entire length of the upper part of the walls, with subjects admirably painted on them, in oil, by Mr. Collins, representing the various products of the globe, its birds, and its animals, &c. This enormous pavilion is now being filled with plants indigenous to the American continent, which will be all beautifully in flower in three weeks, forming a whole of surpassing floral beauty. Some idea of the number of the plants may be formed, when we state that they comprised 100 wagon loads, supplied from the nursery grounds of Waterer and Godfrey, of Woking. When the plants and shrubs have ceased flowering, it is intended to remove them to their original quarters, lay the floor with boards, when the vast area may be used for public banquets, or for promenades, in which latter case it is calculated to accommodate 25,000 persons. Mr. Thompson is the architect of the structure, and the waterproof canvass was supplied by Messrs. Orchard and Canington, of Brick-lane. There are also in preparation, in the grounds, two pictorial out-door representations of the castle of Barfleurs, in the time of Henry V., and an immensely large one of the city of Berne, in Switzerland (which latter is painted entirely on a *flat surface*), with its magnificent mountain scenery, and a projected facsimile of a Swiss hostlery at the foot of the mountains. These works reflect very great credit on the artist, Mr. Jones, who has executed them,—the hazy mists settling in the deep ravines of the rocks being remarkably true to nature.

Mr. Thompson, of Weymouth, gives an account in the 'Journal of the Society of Arts' of the means he adopted for taking a photograph of the bottom of the sea in Weymouth bay, at a depth of three fathoms. It appears that the camera was placed in a box with a plate-glass front, and a moveable shutter to be drawn up when the camera was sunk to the bottom. The camera being focussed in this box on land for objects in the foreground at about 10 yards, or other suitable distance, was let down from a boat to the bottom of the sea, carrying with it the collodion-plate prepared in the ordinary way. When at the bottom the shutter of the box was raised, and the plate was thus exposed for about ten minutes. The box was then drawn into the boat, and the image developed in the usual manner. A view was thus taken of the rocks and weeds lying in the bottom of the bay. Mr. Thompson anticipates that it will be a ready and inexpensive means of arriving at a knowledge of the condition of piers of bridges, piles, structures, and rocks under water.

The foundation stone of the Holmfirth Monumental Almshouses, erected to commemorate the great flood caused by the bursting of the Bilberry reservoir, in February 1852 (by which upwards of eighty lives were lost), and also the munificent liberality of the British public, was laid by the Provincial Grand Lodge of Freemasons of West Yorkshire, on the 21st April.

A discovery was made recently on the farm of Abbey Flats, which forms part of the glebe lands in the incumbency of the Rev. Mr. Wintour, rector of Barton-upon-Trent. Barton has long been known to afford indications of Roman remains. In particular the homestead of the farm of Abbey Flats has been quite celebrated for possessing a fold-yard paved with the small diced tiles of the conquerors of the world. Passages of these tiles are distinctly visible in the fold-yard, and it is in the field immediately adjoining it to the east that the present discoveries have been laid bare. For a long time it has been noticed that square patches situate at intervals over the surface of this field have either failed to produce crops, notwithstanding the fertility of the red clay of which the field is composed, or have presented squares of scanty and stunted produce, in great contrast to the rest of the field. The cause has now been disclosed. While ploughing in this field a few days since, the plough struck against the edge of what proves to be a tesselated pavement not a foot beneath the surface. Some labourers having set to work, gently cleared the surface, and, at the depth of a foot, laid bare about one-fourth, diagonally, of a superb pavement of bold and elegant geometrical designs, in red, white, and blue. From the appearances and the traces of passages or walks leading through the field, it is conjectured that the Abbey Flats must have been the site, not merely of a single Roman villa, but of numerous houses. The space thrown open forms an oblong rectangle, measuring 15 by 10 feet, extending lengthwise due east and west. This rectangle is occupied by an outer border of small red half-inch tiles, 3 feet broad on the west and 1½ foot on the south. This is succeeded by an inner border of blue, 9 inches broad; and then by delicate double lines of small white tiles, including a magnificent scroll border 6 inches broad, of interlacing red, white, and blue tiles, succeeded by another delicate double white line. The centre part within this brilliant bordering (separated from it by a double line of blue) is occupied with a great variety of geometrical figures. In all these the colouring of the tile is remarkably brilliant. The flooring appears to be laid down on cement, which, however, reposes upon artificial soil of very great depth, presenting the colour of a dark fertile mould very unlike the red clay of the field in general. In causing the soil to be dug up around the site of these discoveries, Mr. Wintour has met invariably, intermixed with the soil, small pieces of charred wood, as if the edifices here situated had been completely destroyed by fire. Large stones and traces of wall foundations are, however, discovered abundantly in the field.

The municipality of Marseilles have decided to provide the city with 100 additional clocks, constructed on the electro-magnetic system. The first laying of the wires will occasion some outlay (30,000 francs), but the further keeping them in action will make but a nominal addition to the expenses of the city.

There has been put up of late such a beautiful specimen of wrought-iron railing in front of the Bourse at Hamburg, that the French government, it is said, has despatched designers for the purpose of copying it, and to have a facsimile executed for some portion of the Louvre. German artists and lawyers duly ask whether such a proceeding is in accordance with law, or, at least, honour.

The Pavillon de l'Horloge, Louvre, is on the point of completion; it was begun under Francis I., and continued in 1548 by Henry II. Under Louis XIII. the upper part was finished, and ornamented by three pediments, and those gigantic caryatides sculptured by Sarrazin. The interior of the building will be partly occupied as a residence for the Director-General of the French Museums. Near the Pavillon is the salle called Les Cent-Suisses. It is ornamented in the Doric style, and the colossal caryatides are the work of Jean Goujon. It was here, in the first year after the revolution, that the sittings of the French National Institute were held. That part of the Louvre of which the Pavillon de l'Horloge forms the centre, is the most richly ornamented, and the decorations which are now being added opposite the Caroussel, will bring the whole into a perfect and pleasing harmony.

In digging in a *Vigna*, on the old Appian way not far from Rome, the labourers broke through into a passage excavated in the volcanic tufa of that neighbourhood, which on examination turned out to be an unexplored branch of the great catacomb of Saint Stephano; it is expected that it will produce, when a scientific search has been made in it, many very interesting relics of the earliest Christians, in monograms and incriptions, and possibly frescoes.

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NEW PATENTS.

PROVISIONAL PROTECTIONS GRANTED UNDER THE PATENT LAWS AMENDMENT ACT.

Dated January 17.

131. J. Platt and J. Whitaker, Oldham—Improvements in machinery or apparatus for doubling or twining yarns or threads, parts of which improvements are also applicable to mules for spinning

Dated March 6.

560. T. B. Sharp, Atlas Works, Manchester, and T. Forsyth, Manchester—Improvements in coupling railway rolling stock
561. L. D. Jackson, Alfred-place, Alfred-road, and H. Myers, Alfred-road, Paddington, The combining air and water as a power
562. H. D. Pochin, Salford—Improvements in the manufacture of aluminous and siliceous compounds
563. R. Philip, Suffolk-parade, Cheltenham—Improvements in paddle-wheels for propelling vessels in water
565. R. Morrison, Newcastle-upon-Tyne—Improvements in pile-driving machinery
566. B. Browne, Stockwell, Surrey—Improvements in the construction of spindles for locks and latches, and in the mode of connecting the same thereto, and to their respective knobs
567. A. Neuburger, Rue de l'Echiquier, Paris—Extraction of oil from a vegetable substance not hitherto so used
568. J. W. Scott, Worcester—An apparatus for fastening or securing buttons, which may itself be used as a stud or button
569. R. A. Brooman, Fleet-street—Improved method of creating a vacuum, together with certain arrangements of apparatus for preserving substances liable to injury or corruption from prolonged exposure to the atmosphere. (Communication from Dr. Girrud)

Dated March 11.

588. J. Collins, Birmingham—A machine for pulverising, crushing, pressing, and cleaning land

Dated March 31.

774. G. Bird, Glasgow—Improvements in the application of asphaltic or bituminous compositions for building and structural purposes

Dated April 2.

791. F. Young, Norwich—Improved two-wheeled open vehicle or carriage

Dated April 3.

803. W. Jenkins, Neath Abbey, Cadoxton-juxta-Neath, Glamorgan—A new and improved method of manufacturing copper rollers for calico printing
804. E. A. Pontifex, Shoe-lane, and W. Needham, Vauxhall—Improvements in the manufacture of preparations or primings used for preparing canvas, wood, or other material for the reception of pigments or colours
805. C. C. Smith, Wolverhampton—A new or improved method of working breaks for stopping machinery used for raising coals and minerals, and for stopping steam-engines and other motive power engines
806. W. Billinton, Great George-street, Westminster—Improvements in strengthening and preserving wood and timber
807. H. R. Abraham, Essex House, Barnes—Improvements in passenger, exhibition, or delivery tickets or checks, and in the method of indicating and recording passenger traffic, or delivery of goods, and in the machinery used as tell-tales for such purposes
808. T. White, jun., Portsmouth—Improvements in slips and ways for receiving ships or vessels requiring repair, and for apparatus to be used for hauling up ships or vessels
809. F. W. Kitson, Leeds—Improvements in the manufacture of railway wheels
810. J. H. Glassford, Glasgow—Improvements in the production or preparation of printing surfaces
811. J. Bannehr, Exeter—An improvement in manufacturing or preparing paper for, and in mounting copies of, written documents thereon
812. J. Fernie, Forrester-street, Derby—Improvements in hoists by combining steam and a hydraulic column

Dated April 4.

813. P. E. Chappuis, the Patent Reflector Factory, Fleet-street—Improvements in looking-glasses to render them double reflective
814. R. Halliwell, Bolton-le-Moors, Lancaster—Improvements in the machines for spinning called self-acting mules (Communication)
815. C. D. Gardissal, Bedford-street, Strand—The treatment or preparation of fabrics or textile materials to be dyed or printed. (Communication)
816. S. Fisher, Birmingham—Improvements in the manufacture of anchors, shafting for mill and engine purposes, axles, cranks, and spindles, and in the furnaces or muffles used in the said manufacture
817. J. Roberts, Upnor, Kent—Improvements in the manufacture of ornamental tiles
818. C. W. Ramié, Denbigh-street, Pimlico—Improvements in constructing the permanent ways of railways
819. G. T. Bousfield, Loughborough-road, Brixton—Improvements in moulding planes. Communication
820. J. G. Marcien, Newark, New Jersey, U.S.—Improvements in the manufacture of iron

Dated April 5.

821. J. Jones, Warrington, Lancaster—Improvements in railway chairs, and in the method of securing the rails to the same
822. J. Hogg, South Blacket-place, and J. Napier, East Sciennes-street, Edinburgh—Improvements in stereotyping
823. O. Blake, Thames Plate Glass Works, Blackwall—Improvements in the manufacture of glass
824. B. Kisch, Kennington—An apparatus for containing an arrangement of cards or papers for selection. (Communication)
825. J. Webster, Birmingham—A new or improved elastic metallic tube, and the method of manufacturing the same
826. A. R. Whitehead, Manchester—Improvements in garments or apparatus to be used for sustaining the human body in water, or for acquiring the art of swimming
827. J. Bernard, Albany, Piccadilly — Improvements in machinery or apparatus employed for manufacturing or making boots and shoes, or other coverings for the feet
828. E. Martin, Oxford—An improved leg guard
829. H. T. Sturley, South Lynn, Norfolk—An improved compound or breakfast mixture
830. A. Morton, Wakefield, York—Improvements in the manufacture of paints and pigments
831. W. P. Maddison, Barnsley, York—An improved telegraph or apparatus for the transmission of signals
832. W. H. Moore, Wenlock-place, City-road—An improvement in the manufacture of candles
833. F. G. Underhay, Well's-street, Gray's-inn-road—Improvements in apparatus for drawing off water
834. H. Craigie, Edinburgh—Improvements in heating apartments where gas and water are used
835. J. Betteley, Liverpool—Improvements in the manufacture of iron for knees for ships or other purposes

Dated April 7.

837. J. Smith, Union-court, Old Broad-street, and J. Luntley, New Broad-street-court—Treating the sunflower plant to render its fibres applicable to the manufacture of textile fabrics, paper, yarn, cordage, &c.
838. J. Leigh, Manchester—The use or application of a certain substance or substances in the sizing, stiffening, or otherwise preparing cotton, linen, or other yarns and woven fabrics
839. E. Morris, Bergen, New Jersey—Improved machinery for raising and lowering weights
840. W. E. Newton, Chancery-lane—An improved construction of furnace for the manufacture of glass. (Communication)
841. C. D. Gardissal, Bedford-street, Strand—Preparing various resins and combining them with oils and fatty matters for manufacturing candles thereof. (Communication)
842. A. Morton, Wakefield, York—Improvements in the manufacture of paper-hangings for decorative purposes
843. W. Terry, Birmingham—Improvements in breech-loading fire-arms
844. W. C. Fuller, Bucklersbury, Cheapside—Improvements in constructing and adapting india-rubber as tyres for wheels
845. J. Adams, Grosvenor-street, Leicester—Improvements in knitting machinery
846. W. H. Gauntlett, South Bank Ironworks, Eston Junction, Middlesboro'-on-Tees—Improvements in thermometric apparatus
847. J. Graves, London, and W. F. Henson, Hampstead—Improvements in lubricating carriage and other axles

Dated April 8.

848. S. J. Gold, Newhaven, Connecticut, U.S.—An improvement in apparatus for warming buildings by steam
849. J. C. Bowser, Queen's-terrace, St. John's-wood—Improvements in glove-fastenings
850. A. C. L. Devaux, King William-street—Improvements in the construction and the fitting up of granaries
851. W. E. Newton, Chancery-lane—Improvements in the process of manufacturing steel, and carbonising iron, and the ores thereof, in the said manufacture. (Communication)
852. W. J. Curtis, Sebbon-street, Islington—Improvements in lubricating the axles of locomotive engines, and of carriages on railways
853. J. A. Ransome and G. A. Biddle, Ipswich—Improvements in the manufacture of railway bars and flanch bearers of railway crossings
854. J. Brooke, Crescent, Jewin-street, City—Improvements in lift pumps

Dated April 9.

855. J. Gedge, Wellington-street, South—Improvements in the treatment or preparation of leather, and in the manufacture of articles composed thereof. (Communication from M. Sejac, Paris)
856. J. R. Whitgreave, Rugeley, Stafford—Improvements in the arrangement and construction of locomotive engines
857. H. Laxton, Arundel-street, Strand—A new and improved apparatus for increasing the buoyancy of ships and other vessels. (Communication from A. le Mot, U.S.)
858. R. Chrimes, Rotherham—Improvements in buffers and other springs for railway and other carriages
859. J. Armour, Kirkton Bleach Works, Renfrew—Improvements in bleaching textile fabrics and materials
860. G. F. Morrell, Fleet-street—Improvements in the manufacture of railway chairs

Dated April 10.

861. H. Laxton, Arundel-street, Strand—An improved mode of adjusting circular saws. (Communication from A. D. Highfield and W. H. Harrison, U.S.)
863. A. V. Newton, Chancery-lane—Improvements in the means of attaching together or securing sheets and pieces of paper or manuscript documents. (Communication)
864. W. Hall, Erith, Kent—A method of stopping or retarding the way of ships and vessels, in order to prevent collisions and otherwise
865. G. Homfray, Ruabon, Denbigh—An improvement in furnaces

Dated April 11.

866. H. Henderson, Glasgow—Improvements in water closets
867. T. W. Makin, Long-sight, near Manchester, and J. Barnsley, Stockport, Chester—Improvements in machinery or apparatus for embossing moiré antique water on all kinds of woven fabrics
869. J. Burnside, Henry-street, Sunderland — Improvements in apparatus for propelling and steering ships and boats
870. P. A. Lecomte de Fontainemorean, South-street, Finsbury—An improved apparatus for measuring the speed of currents of air and water. (Communication)
871. G. Jackson, Bilston, Stafford—A new or improved steam boiler, to be heated by the waste heat of puddling or mill furnaces
872. R. Davis, Oxford-street—Improvements in the construction of tobacco-pipe stems
873. A. Perpigna, Paris—Improvements in the manufacture of coke. (Communication)

Dated April 12.

874. J. Mash, Manchester—Improvements in the fusible plugs and furnaces of steam-boilers
875. L. Schultz, Green-street, Stepney—Improvements in obtaining photographic pictures upon paper, glass, metal, plates, and other fibrous substances
876. R. S. Newall, Gateshead-upon-Tyne, Durham — Improvements in telegraphic insulators
877. W. B. Flint, Birmingham—Improvements in fasteners for shutters, windows, doors, and such like purposes, and which said fastening is also applicable to the coupling of railway carriages and trucks, and other useful purposes
878. F. Nuibo-y-Pedros, Rue de l'Echiquier, Paris—A new motive power
879. R. B. Lindsay, Mill Wall Brewery, Poplar—An improvement in removing the scale or deposit from tubular flues of steam-boilers

Dated April 14.

880. E. Heywood, Sutton, near Keighley, York—Improvements in fixing apparatus for generating steam, whereby smoke will be prevented or consumed, and fuel economised
881. G. Braden and C. Braden, Sharp's-alley—Improvements in the manufacture of show tablets for advertising purposes
882. P. Robertson, Shawlands-hill, Renfrew—Improvements in power-loom weaving
883. J. Symonds and T. M. Fell, Sufferance Wharf, Mill Wall, Poplar—Improvements in the reduction of gold, silver, and other ores
884. R. Richardson, Great George-street, Westminster — Improvements in railway switches
885. G. Davies, Serle-street, Lincoln's-inn—Improvements in the method of soldering or uniting cast-iron. (Communication from M. J. Receveur)
886. L. P. Coulon, Rue de l'Echiquier, Paris—A new type-distributing and composing machine. (Communication)
887. J. Bridgwood, Burslem, Stafford—An improvement in the manufacture of china and earthenware plug wash-hand basins. (Communication)
888. J. Barrans, New-cross, Deptford—Improvements in constructing steam-engines
889. S. C. Lister, Bradford—Improvements in spinning
890. W. Warren, Northampton-park, and Warren de la Rue, Bunhill-row—An improvement in the manufacture of envelopes
891. S. C. Lister, Bradford—Improvements in weaving

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892. L. Kaberry and A. Howfield, Rochdale, Lancaster—Improvements in moulding for casting certain parts of machinery, used in the preparation and spinning of cotton and other fibrous materials
893. A. V. Newton, Chancery-lane—Improved machinery for felting hat bodies. (Communication from J. S. Taylor, Danbury, Connecticut, U.S.)
894. A. V. Newton, Chancery-lane—An improved mode of constructing grate-bars. (Communication from J. Beal, A. D. Melick, and T. de Witt, New York)

Dated April 15.

895. H. F. Forbes, Park-place, Regent's-park—Improvements in breech-loading fire-arms and ordnance, and in projectiles used therewith
896. W. H. Olley, Brabant-court, Philpot-lane—Taking photographic impressions or pictures of microscopic objects by reflection, such reflection being effected by the combined aid of the microscope and camera obscura and camera lucida or other reflectors that may be employed in place of the latter
897. W. Smith, Aston, near Birmingham—Improvements in the manufacture of steel wire for musical and other purposes
898. T. Jeffries, Reading—Improvements in cooking-stoves
899. E. R. Southby, Bulford Amesbury, Wilts—An improvement in coating iron with copper
900. J. Bemain, Markington, York—Improvement in connecting railway carriages
902. W. Fuller, Jermyn-street—Improvements in ice pails

Dated April 16.

903. W. Routledge, Salford—Improvements in the construction of steam-engine and other boilers to prevent explosions
904. E. N. Norminton, Charrington-street, St. Pancras—The manufacturing of railway grease for the cleansing and remanufacturing of old used dirty railway grease or greases, for the cleansing and remanufacturing of old dirty cotton waste, tow, or any textile fabric
905. F. Priestley, Cleveland-street, Fitzroy-square—Improvements in pianofortes
906. D. B. White, Newcastle-upon-Tyne—An improvement or improvements in cylinder pistons or plungers
907. T. Mellowdew and J. Duxbury, Oldham, Lancaster—Improvements in shuttles for weaving
908. A. V. Newton, Chancery-lane—Improvements in fire-arms and powder flasks. (Communication from Col. S. Colt)
909. W. E. Newton, Chancery-lane—Improved apparatus for raising sunken vessels and increasing the buoyancy of floating vessels. (Communication from T. Bell, New York)
910. J. H. Johnson, Lincoln's-inn-fields—Improvements in cleansing and hulling grain and seeds, and in the machinery or apparatus employed therein. (Communication from C. T. Laborey, Paris)
911. W. Armitage and H. Lea, Farnly Iron Works, near Leeds—An improvement in the manufacture of iron
912. W. Little, Strand—Improvements in lamps for burning paraffine and bituminous oils or naphtha
913. W. Wilkinson, Hull—Improvements in steam-engines

Dated April 17.

914. C. Hulme, S. Ivers, and J. Yardley, Farnworth, Lancaster—Improvements in power-looms for weaving
915. H. Y. D. Scott, Brompton barracks, Chatham—An improved mode of manufacturing cement
916. J. H. Johnson, Lincoln's-inn-fields—Improvements in the manufacture of tyres. (Communication from Messrs. Jackson, Brothers, Petin, Gaudet, and Co., Rive de Gier, France)

Dated April 19.

935. C. Moret, Rue de l'Echiquier, Paris—Improvements in rotary steam-engines
937. T. Blackburn, Brighouse, York—Improvements in preparing for spinning cotton-waste and silk-waste
938. E. Hunt, Walnut-tree-walk, Lambeth, Surrey—Improvements in Hansom cabs and similar vehicles, parts of which improvements are also applicable to other carriages
939. C. F. Stansbury, Gracechurch-street—A new instrument for determining the position and bearing of ships at sea. (Communication)
940. W. Adkins, Smallbrook-street, Birmingham—Measuring fabrics which he proposes designating the automaton measurer or draper's assistant
941. T. Wilkes, Birmingham—A new or improved method of manufacturing tubes of copper and alloys of copper
942. W. J. J. Varillat, Rouen—Improvements in the apparatus for the extraction of colouring, tanning, and saccharine matters from vegetable substances
943. E. Hazard, Thanet-place, Strand—A heat extractor for extracting the heat from the smoke or heated gases in its passage from boilers, stoves, or furnaces to the chimney, and rendering the economised heat available for drying and warming purposes
944. A. Longbottom, Moorgate-street—Improved means of lighting and ventilating mines
945. W. Crosley, Westbourne-park, and G. Goldsmith, Leicester—Improvements in wet gas-meters
946. F. J. Bouwens, Malines, Belgium—A new rotative steam-engine

Dated April 21.

947. P. Heyns, Poplar—Improvements in railway-wheels
948. J. Nasmyth, Patricroft, near Manchester, and H. Minton, Stoke-upon-Trent, Stafford—Improvements in machinery or apparatus employed in manufacturing tiles, bricks, and other articles from pulverised clay
949. S. Mellor, Salford, Lancaster, and T. Young, Manchester—Improvements in machinery for supplying water to steam-boilers
950. J. Dortet, Paris—An improved padlock
951. W. Owen, Lincoln's-inn-fields—Improvements in the modes of attaching buttons to wearing apparel
952. J. A. M. T. Chambor, Paris—Improvements in fire-places
953. W. Maughan, Ifield-terrace, Stockwell, Surrey—An improvement in the preparation or manufacture of starch
954. J. Hanson, Portland-place, Wandsworth-road, Surrey—Improvements in the manufacture of illuminating gas

Dated April 22.

955. W. J. Cantelo, Southwark—Improvements in the preservation of vegetable matters
956. J. T. Stroud, Suffolk-street, Birmingham—Improvements in stop-cocks or taps for regulating or cutting off the passage of gas to combined gas-burners
957. A. Symons, George-street, Mansion-house, and E. Burgess, Clerkenwell-green—Improvements in instruments for ascertaining and indicating heat, and also in the parts for making and breaking contact in electric circuits used therewith
958. A. Symons, George-street, Mansion-house, and E. Burgess, Clerkenwell-green—Improvements in apparatus for producing alarums to indicate burglary by means of electricity
959. A. S. Vimont, Vire, France—A new system of machine for spinning wool and any other fibrous material
960. A. V. Newton, Chancery-lane—A new method of obtaining purified oil from coal, shale, and other bituminous substances. (Communication from A. E. Beach, New York)
961. P. Brown and G. Brown, Liverpool—Improved apparatus applicable to furnaces, fire-grates, fire-places, or stoves, for the purpose of economising fuel and heat
962. W. Smith, Woolston, Fenny Stratford—Improvements in constructing and applying windlasses for working ploughs and other agricultural implements
963. C. Nickels, Albany-road, Camberwell, and J. Hobson, Leicester—An improvement in machinery for weaving carpets and terry fabrics
964. D. Lloyd, Ebbw Vale Iron Works, South Wales—Improvements in washing minerals, coal, and ores
965. T. Jeacock, Bridge-street, Leicester—An improvement in knitting machinery
966. T. E. Blackwell, Cornwallis-grove, Clifton—An improvement in treating water for the use of brewers
967. W. G. Armstrong, Newcastle-upon-Tyne—Improvements in apparatus for lifting, lowering, and hauling
968. R. A. Brooman, Fleet-street—Improvements in or connected with centrifugal machinery. (Communication)

Dated April 23.

970. G. Forster, Standish, near Wigan—Improvements in the arrangement of trap-doors or air-doors, and their cases in the workings or passages in mines, whereby the efficient ventilation is maintained, which said improvements are also applicable in other similar situations
971. A. Bullough, Blackburn—Improvements in looms
972. J. Garnett, Low Moor, Clitheroe, Lancaster—Improvements in twisting, winding, and reeling yarn, and in machinery or apparatus employed therein
973. W. P. Savage, Roxham, Norfolk—A machine for drilling and rolling land
974. T. Squire, Latchford, and C. F. Claus, Chester—Improvements in the manufacture of artificial manure
975. J. S. Perring, Radcliffe, Lancaster—Improvements in chairs for railways
976. W. H. Balmain, and T. Colby, St. Helen's, Lancaster—Improvements in the manufacture of alkalies from their sulphates
977. J. Barbour, Glasgow—Improvements in sawing apparatus
978. P. Ward, the Patent Alkali Works, St. Helen's, Lancashire—An improvement in furnaces used in the manufacture of alkali
979. D. Brown, Smethwick, Stafford—A new or improved method of joining the rails of railways

Dated April 24.

981. A. D. Schratz, St. Denis, near Paris—Improvements in preparing colours for the impression of woven or textile fabrics or stuffs of any kind
982. J. Yeomanson, and W. Yeomanson, Leicester—Improvements in the manufacture of knitted fabrics
983. T. Woodcock and J. K. Punshon, Great Ormond-street—A machine for cutting and slicing bread and other substances
984. G. Ashworth, Sunny-bank Mills, Rochdale—Improvements in machinery for preparing slivers or slubbings of wool and other fibrous materials, commonly called condensing carding-engines
985. C. Cowper, Southampton-buildings, Chancery-lane—A new yarn or thread, and its application in the manufacture of stockings, gloves, and looped and other fabrics. (Communication)
986. F. Allman and D. Bethune, Cambridge-terrace, Hyde-park—Improvements in apparatus for the production of steam, and in the apparatus employed in its application to motive purposes
987. V. Doat, Albi, France—An improved galvanic battery and method of recovering and revivifying the agents employed
988. W. Neilson, Glasgow—Improvements in locomotive engines
989. F. W. Blacket, West Smithfield—An improvement in the construction of keys and locks, and in the fitting of locks, to afford increased safety
990. T. Moore, Retford, Nottingham—Improvements in machinery for riddling and winnowing or cleaning corn and other grain

Dated April 25.

991. W. Naar, Glasgow—Improvements in folding or adjusting articles of furniture
993. J. Hardacre, Manchester—Improvements in the arrangement and construction of carriages and carriage-wheels
994. C. Swift and J. J. Derham, Blackburn—Improvements in steam-engines
995. I. D. Fraétaniel, Paris—An improved safety rein or bridle
996. W. Gossage, Widnes, Lancaster—Improvements in the manufacture of sulphuric acid

Dated April 26.

998. T. Hill, Heywood, Lancaster—Improvements in steam-boilers and furnaces connected therewith
999. T. Lawes, City-road—Improvements in the construction and manufacture of an implement used in tilling the land
1000. E. Topham, Mansfield-road, Nottingham—Apparatus for cleansing out the sediment from the water in steam-boilers and preventing incrustation of the same
1001. M. W. Hilles, Percy-street, Bedford-square—Improved apparatus applicable to the treatment and cure of rupture, prolapsus uteri, and other protrusions of the viscera
1002. W. E. Newton, Chancery-lane—Improved machinery for manufacturing painted or enamelled cloth. (Communication)
1003. C. A. Arnaud, Lyons—Improvements in obtaining motive power from steam and other fluids, and in pumping and forcing water and other fluids. (Communication)
1004. T. Walker, Warwick-place, Pimlico—Improvements in playing cards
1005. A. Vacherot, Paris—Improvements in the construction of submarine tunnels
1006. T. Heiffor, Sheffield—An improved method of manufacturing razor blades

Dated April 28.

1007. G. Napier, Bath-street, Glasgow, and J. Millar, Cavendish-street, Glasgow—Improvements in the manufacture of gas from coal, tar, or other bituminous, resinous, or fatty matter
1008. J. C. B. Dubos, Paris—An improved electro-magnetic apparatus
1009. T. Restell, New Kent-road—Improvements in fittings or appendages for doors, and in the means of fixing or attaching the same
1010. H. Geering, Birmingham—An improvement or improvements in metallic bedsteads, chairs, couches, and other articles for sitting, lying, or reclining upon
1011. W. D. Ruck, Topping's Wharf, Tooley-street—An improvement in tanning hides and skins

Dated April 29.

1012. C. J. Graftiaux, Molenbeck St. Jean by Brussels—Improvements in rotary steam-engines
1013. J. Hick, Bolton-le-Moors—Apparatus for equalising the temperature of the water in that kind of steam-boilers generally called multitubular boilers
1014. J. S. Crosland, Openshow, near Manchester—Improvements in furnaces and steam-generators for locomotive steam-engines and other purposes
1015. T. Greenshields, Little Titchfield-street—Improvements in sleepers for railways
1016. C. Titterton, Rochampton, Surrey—An improvement in the manufacture of white zinc
1017. T. W. Rammell, Trafalgar-square—Improvements in pen and pencil holders
1018. I. A. Boss, Bury-street—Improvements in preparing cane, in order to render it suitable to be used as a substitute for whalebone. (Communication)
1019. W. Pilling, Oldham—An improvement in the treatment of yarns or threads, and in the apparatus connected therewith
1020. J. H. Johnson, Lincoln's-inn-fields—Improvements in anchors. (Communication from L. F. F. David, Havre, France)

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Dated April 30.

1021. J. Smith and W. Craven, Collyhurst, near Manchester—Improvements in machinery or apparatus for dressing, machining, and finishing velvets, velveteens, and other fabrics

1022. F. G. Spilsbury, Chaudfontaine, Belgium, and Southwark—Separating metals, metallic oxides, and metallic acids from their ores

1023. S. Dyer, Bristol—Improvements in reefing, furling, and setting the sails of ships and vessels

1024. J. Rigby, Ashton-under-Lyne, Lancaster—Improvements in machinery for grinding or sharpening the card cylinders and rollers of carding engines

1025. L. J. B. Manevy, Paris—Improvements in manufacturing cast-steel

1026. W. Jones, Pendleton, Lancaster—Improvements in apparatus for regulating the pressure and flow of steam, water, and other fluids

1027. W. E. Newton, Chancery-lane—An improved method of, and machinery for, polishing the surface of glass, stone, metal, or other materials capable of being polished by friction. (Communication from A. Broughton, A. Lindsay, and J. R. Platt, New York, U.S.)

Dated May 1.

1028. N. Defries, Fitzroy-square, and G. H. Bachhoffner, Montague-street—Improvements in gas-fires

1029. H. Mapple, Childs Hill, Hendon—Barometers

1030. W. E. Newton, Chancery-lane—Improved preparation of phosphoric acid. (Communication from E. N. Horsford, Massachusetts, U.S.)

1031. C. Perron and V. Boulland, Paris—Improved knitting machine

1032. S. Carey, Clink-street Wharf, Southwark—Improvements in water-carts and barrows

1033. R. A. Brooman, Fleet-street—Improvements in compressing, regulating the pressure and flow of, and conveying gas, parts of which are applicable to air and other fluid-pumps. (Communication from P. Hugon, Paris)

1034. R. A. Brooman, Fleet-street—Improvements in machinery for felting or planking hat bodies. (Communication)

1035. A. J. Paterson, Upper Eaton-street—An improvement in or connected with hawsers and other ropes or chains used in towing vessels

1036. N. Smith, Thrapston, Northampton—Improvements in clod-crushing rollers, parts of which are applicable to other descriptions of rollers

1037. A. Smith, Wentworth-street—Treating vegetable fibres, in order to fit them for use as a substitute for bristles in paint and other brushes

1038. S. Hunter, Ravensworth-terrace, Gateshead, and Dock Anchor Works, Hartlepool—An improvement in anchors

Dated May 2.

1039. J. Cowley, Quenington, Gloucester—Improvements in the manufacture of paper from straw and other vegetable substances

1040. R. Pearcy, Manchester—Improvements in machinery or apparatus for twisting cotton and other fibrous substances

1041. W. Waite, Cheapside—An improvement in the construction of sleepers and rails for railways

1042. W. Naylor, Norwich—Improvements in power hammers and riveting machines, part of such improvements being applicable to the manufacture of bolts or rivets

1043. W. Day, Campbell-road, Bow-road—Improvements in clod-crushers or rollers for rolling, pulverising, or pressing land

1044. A. Gordon, Fludyer-street—Improvement in evaporating, boiling, and distilling fluids, and generating steam

1045. H. E. Brown, Summer-street, North, Dublin—Improvements in the description of hinges denominatad concealed hinges, for carriage doors and doors of every description

1046. S. Rooke, Birmingham—A new or improved manufacture of stair-rods

1047. R. A. Brooman, Fleet-street—Improvements in machinery for bending or shaping timber. (Communication)

1048. H. A. Thompson, Lewes—Improvements in hay-making machines

1049. R. T. Campbell, Washington City, U.S.—Improvements in machines for reaping and mowing. (Communication)

Dated May 3.

1050. P. A. Lecomte de Fontainemoreau, Rue de l'Echiquier, Paris—Improvements in electric telegraphs. (Communication from A. J. A. Duinoulin, Paris)

1051. J. Wright and T. Gorrery, Sheffield—Improvements in railway carriage and other springs

1053. H. D. P. Cunningham, Gosport—Apparatus to be applied to boats to increase their buoyancy and stability

1054. W. Garside, Vicar-street, Kidderminster—A new and improved method of letting off the worsted or yarn from the bobbins employed in weaving carpets and other similar fabrics in which bobbins are employed during the manufacture thereof

Dated May 5.

1055. C. Bloomer, West Bromwich—Improvements in the manufacture of spikes and bolts

1056. G. Williams, Cannon-street, St. George's-in-the-East—Improvements in fog and dark night alarm signals

1057. W. Bulmer and I. Sharp, Middlesborough—Improvements in the manufacture of bricks, tiles, and other articles from plastic substances

1058. I. Holden, St. Denis, near Paris—Improvements in preparing and combing wool and other fibrous substances

1059. A. Chadburn, Sheffield—An improved construction of pressure-gauge

1060. W. Gregory, Old Church-street, Paddington—An improvement in the construction of roofing tiles

Dated May 6.

1061. A. L. Beudant and J. L. M. P. Benoit, Paris—Improvements in treating ores of copper containing arsenic and antimony

1063. J. Wright, Upnor, near Rochester—Improvements in apparatus for lowering ships' boats

1065. W. E. Newton Chancery-lane—Improved apparatus for connecting boats with their tackle, and clearing or detaching them therefrom when lowered from on board ship into the water. (Communication)

1067. T. Huckvale, Choice-hill, Chipping Norton—Improvements in implements for thinning and hoeing turnips and other crops

Dated May 7.

1069. J. Furnevall, Haslingden, Lancaster—Improvements in the construction of valves

1070. G. Martin, Windmill-street, Camberwell, and A. L. Newman, New Church-street, Bermondsey—Improvements in freeing or purifying animal fibres from admixture with vegetable matters

1071. W. J. Curtis, Sebbon-street, Islington—Improvements in carriages to run on rail or tramways and common roads

1072. R. Heaton, jun., H. Heaton, and G. Heaton, Birmingham—A new or improved manufacture of balance weights used for counterbalancing pendant lamps and chandeliers, and for other like purposes

1073. S. A. Bell and J. Black, Bow-lane—An improved method of, and preparation for, igniting matches

1074. J. Périnaud, Paris—Improvements in preparing or dressing silks

1075. R. Royds, Southampton—An improvement or improvements in the manufacture of soap

Dated May 8.

1076. L. G. Perreaux, Rue M. le Prince, Paris—An improved valve

1077. C. Schneider and F. Leiss, Hesse Darmstadt, Germany—Manufacturing a safety boiling apparatus

1078. L. F. Mayer, Regent-street—Improvements in photography

1079. A. E. Riddle, Walbrook, and I. H. Boyd, Mansion-house-place—The improvements in tanning by machinery and chemicals. (Communication from G. F. Kendall)

1080. J. Niven, Keir, Perth—Improvements in the manufacture of paper, and in the production of textile materials

1081. J. G. Lawrie, Glasgow—Improvements in steam-engines

1082. J. Amory, Boston, Massachusetts, U.S.—Improvements in furnaces for locomotive and other steam boilers, which improvements are applicable to reverberatory and puddling furnaces, and to furnaces for heating buildings

1083. C. W. Finzel, Bristol, W. Needham, Smallbury-green, Middlesex, and J. Barton, Shoe-lane—Improvements in apparatus for filtering sugar and saccharine juices

1084. R. A. Brooman, Fleet-street—Improvements in machinery for felting or sizing hat bodies. (Communication)

1086. W. E. Newton, Chancery-lane—Improved machinery for cutting, punching, and forging, or swaging nuts or washers. (Communication)

1087. A. C. L. Devaux, King William-street—Improvements in the construction of granaries

1088. A. V. Newton, Chancery-lane—An improved construction of rotary pump. (Communication)

1089. A. V. Newton, Chancery-lane—An improvement in bands for securing bales of goods, and for other like uses. (Communication)

1090. S. W. Underhill, Wellfield Cottage, Dunse, Berwick—The preservation of life in cases of shipwreck or other casualty at sea, the Buoyant Cushion

Dated May 9.

1091. L. L. Jardin and J. Blamond, Rue de l'Echiquier, Paris, and South-street, Finsbury—Improvements in engraving on stone, earthenware, china, and glass, and also in ornamenting the same

1092. W. Bayliss, Wolverhampton—Improvements in chains for collieries, cables, and other purposes

1093. J. H. Johnson, Lincoln's-inn-fields—Improvements in carding engines for carding cotton and other fibrous materials. (Communication from G. Wellman, Lowell, U. S.)

1094. J. W. Hackworth, Priestgate Engine Works, Darlington—Improvements in machinery or apparatus for raising and lowering heavy bodies

1095. F. Potts, Birminghaw, and T. Vann, Cheapside, Birminghm—Machinery for ornamenting, floating, burnishing, and polishing metallic tubes, part of which machinery is also applicable for performing the like operation upon other metallic surfaces

1096. E. D. Johnson, Wilmington-square—An improved mode of mounting marine chronometers

1097. G. J. Firman, Newton-le-Willows, Lancashire—Improvements in the manufacture of sulphuric, tartaric, citric, and oxalic acids, ammonia, and cyanides

1099. W. Basford, Talbot-road, Kentish-town—Improvements in apparatus for purifying coal gas

1100. L. Beauché, Offenbach, near Frankfort-on-the-Maine—A machine for the manufacture of cigars

1101. G. Simpson, Leather-lane—Improvements in rotary knife-cleaning machines

1102. R. A. Brooman, Fleet-street—An improvement in cranes. (Communication from C. R. Neustadt)

1103. R. A. Brooman, Fleet-street—Improvements in machinery for the manufacture or finishing of tyres, hoops, and rings. (Communication from A. Duboy, Givors)

Dated May 10.

1105. R. A. Brooman, Fleet-street—Improvements in machinery for manufacturing tubes and pipes, applicable also to the rolling of rods and bars. (Communication)

1107. J. H. Johnson, Lincoln's-inn-fields—Improvements in machinery or apparatus for cutting irregular forms. (Communication from H. D. Stover and J. W. Bicknell, Boston, U. S.)

1108. J. Wallace, jun., Glasgow—Improvements in preparing, bleaching, washing, cleansing, and drying textile fabrics and materials and pulpy substances

1109. R. Wotherspoon, Glasgow—Improvements in hats and other coverings for the head

1110. J. H. Johnson, Lincoln's-inn-fields—Improvements in drying leather and dressed skins. (Communication from M. A. Brothers, Paris)

1111. J. Ridal, Sheffield—Improvements in spring knife handles

1112. W. Burkin, Neate-street, Old Kent-road—Improved machinery for manufacturing painted cloths

1113. B. Beniowski, Bow-street, Covent-garden—Improvements in typographical composition, and in the manufacture of logotypes to be used therein

Dated May 12.

1114. C. F. Claus, Latchford, Chester—Moistening land, streets, and the better extinction of fires

1115. P. E. Aimont, Paris—Improvements in manufacturing shoes and other coverings for the foot

1116. R. Whytock, Edinburgh—Improvements in apparatus to facilitate the printing of yarns or threads

1117. E. B. de la Pontonerie—Improvements in the apparatus for consuming smoke. (Communication)

1118. B. Samuel, Sheffield—Improvements in the manufacture of combs

1119. W. E. Newton, Chancery-lane—Improvements in machinery for forcing and pumping water and other fluids. (Communication from G. Denison, United States)

1120. W. E. Newton, Chancery-lane—Improved machinery for splitting or cutting blocks of wood, for match splints, kindling wood, treenails, and other purposes. (A communication)

Dated May 13.

1121. C. B. Clough, Llwyn Offa, Flint—Improvements in elongating and contracting metal bars or rods for the obtainment of motive power

1125. A. Parkes, Birmingham—An improvement in preparing materials for and in waterproofing and coating woven and other fabrics, paper, leather, and other substances

1127. R. Raywood, Peniston, York—Improvements in railways

1129. W. E. Newton, Chancery-lane—Improved machinery for removing snow from railroad tracks. (Communication)

Dated May 14.

1131. H. Bragg, jun., Belfast—Improvements in machinery or apparatus for finishing linen and other fabrics

1133. H. Groves, New York—Improvements in tune barrels or cylinders, or other apparatus for playing upon organs or other musical instruments

1137. A. Tolhausen, Duke-street, Adelphi—Improved distance indicator for public carriages. (Communication from C. A. L. Mannory, Berlin)

1141. C. H. Olivier, Finsbury-square—Improvements in the mode of preparing and applying silk waste

1143. W. Crofts, Derby-terrace, Nottingham-park—Improvements in the manufacture of lace and other weavings.

ERRATUM.—In our Paper headed "Architectural Improvements of London," under the notice of Messrs. Munt, Browne, and Co's new premises, in Wood-street, Cheapside, for "Messrs. Miller and Co., of Blackwall," read "Mare and Co., of Blackwall."

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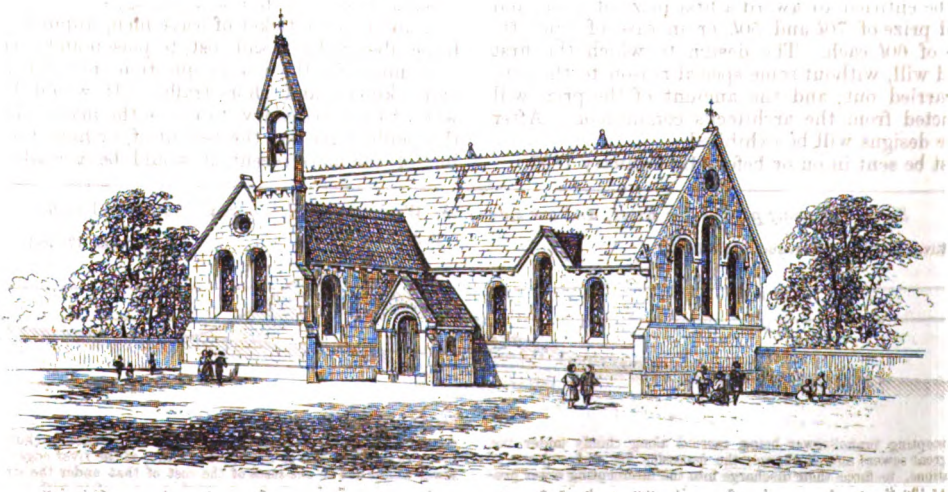
St PAULS CHURCH, CHATHAM.

A.D.GOUGH, ARCHT.



St PAULS SCHOOLS, CHATHAM.

A.D.GOUGH, ARCHT.

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ST. PAUL'S CHURCH, CHATHAM.

(With an Engraving, Plate XVIII.)

THE principal feature of our plate represents a perspective view of an adaptation of the Anglo-Norman style of architecture of the twelfth century to the requirements of a modern church. The arrangement is that of a Latin cross, consisting of nave and transepts, with a very effective semicircular termination forming the chancel. The tower occupies the south-east intersection of the nave and transept, and a stair-turret the opposite angle. Ancient examples appear to have been less studiously followed in general form than in the details, which are more strictly carried out and are in good keeping, quite characteristic of the style. adopted. Some boldly-executed surface-carving in the principal doorways, chancel arch, south porch, and parts of the tower, are worthy of observation, and amply compensate for much that is unattractive in this style. A good stone pulpit and font, and some arcade work in the interior, are also deserving of attention.

The church appears to have been designed expressly to fit into a somewhat inconvenient site, the slope of a hill below the level of the road. Access on the south side is obtained by a broad flight of terrace steps from the road to the porch below, which, it should be observed, is one of its most attractive features.

The structure, which was consecrated last year, has accommodation for 1010 persons, and the total outlay for the site, church, and boundary wall was within 4850*l.*

The architect is Mr. A. D. Gough, of Lancaster-place, Waterloo bridge.

The schools and teachers' residence, in connection with the church (of which we give a vignette), are shortly to be commenced; they are estimated at 1300*l.* It is also, we learn, in contemplation to erect a parsonage-house in harmony with the style of the church, as soon as the funds, which are fast progressing, are obtained.

PROPOSED MEMORIAL CHURCH, CONSTANTINOPLE

THE committee entrusted with the arrangements have invited architects to send in designs for the above structure. The competition will be unlimited and anonymous. The style must be a modification, to suit the climate, of the recognised Ecclesiastical architecture of Western Europe, known as Pointed, or Gothic, and the neglect on the part of any architect of this provision will absolutely exclude from competition.

The church must be of sufficient capacity to hold without galleries a congregation of not fewer than 700 persons, while the cost must not exceed 20,000*l.*, a sum sufficient in the hands of an able architect to ensure the monumental character of the structure.

In order to insure competence and impartiality in the adjudication, the committee have entrusted the selection of the successful designs to the following gentlemen:—The Right Rev. the Lord Bishop of Ripon; Sir Charles Anderson, Bart.; the Very Rev. the Dean of Ely; the Rev. Professor Willis; and A. J. B. Beresford Hope, Esq.

The judges will be entitled to award a first prize of 100*l.*, and a second and third prize of 70*l.* and 50*l.*, or in case of equality, two second prizes of 60*l.* each. The design to which the first prize is adjudicated will, without some special reason to the contrary, be the one carried out; and the amount of the prize will be ultimately deducted from the architect's commission. After the decision, all the designs will be exhibited.

The designs must be sent in on or before 1st January 1857.

THE THAMES——METROPOLITAN INTERCOURSE AND HEALTH.

SIR—As the excitement natural to a state of warfare has subsided with the Peace which we have celebrated, we may be permitted, and in fact it is a duty, to cultivate the more useful arts, and, as opportunity admits, to put our home in order.

One of those opportunities, and a great one, offers just now, and it would afford a profitable demand for all the extra hands that peace may restore to us,—I allude to the dispollution of the Thames, and the formation of thoroughfares by it.

If the drainage of this great city was perfect, and the *only* evil to be complained of was that the sewers discharged everything into the Thames, the hydra that the Metropolitan Board of Works have to contend with in discharging their duty to the public, would have lost many of its heads.

But the sewerage is *not* perfect, and therefore that imperfection must be grappled with, for no deodorisation of their present contributions to the Thames would meet the deficiencies of the sewers, or enable them, as they now exist, to gather up what they, the sewers, notoriously leave behind or are insufficient for. In order, however, to progress with our consideration of the whole project, we may suppose that the sewers *are* perfect, or that means are contemplated and understood by which they will be rendered perfect,—that is, collected into the present main arteries; or others in addition, or better in lieu thereof. Then comes the question of *interception*, which appears to be determined on; but at what and how many levels? For it would be obviously a waste of power to allow all to flow down, even to the present lowest level, having in that case to lift all (instead of a part) to a level above the surface of the Thames again.

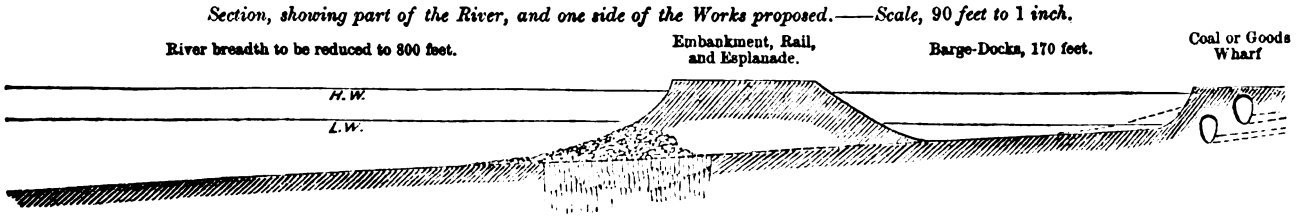
With the higher interception, those quite above the river, which no doubt have already been well-considered, I do not imagine that any very great difficulty can arise. Their offerings may at ease be sent, if such be willed, to taint the air of some unfortunate and distant locality; or they may be deodorised, and deprived of their agricultural riches, on Mr. Richard Dover's or Mr. Wicksteed's plan, or any other, at some of the many suitable places nearer home. It is for the present lowest level and a level lower still which large tracts north and south of the river notoriously require, that we have now to provide and consider.*

On the 28th July, by a letter inserted in the *Illustrated London News*, and on the 3rd September, by another letter inserted in the *Morning Post* on this subject, I called on the public *generally*, and on those acting particularly for them, *to take a more comprehensive view of this great question*, as in truth the only way of effecting anything very perfect, or at all worthy of so vast a city.

The question that really calls for the consideration of professional men, and of sensible and practical men, is, *how* best and *where* best to provide for and to form those two conduits which I call the *low* and the *lowest level* intercepting tunnels or drains. This question must be met, and it is better to meet it in time, and to consider whether the teeming riches of some hundreds of miles of sewers is to be filtered as it is formed, or to be flowed and flushed to Woolwich or to Barking,—there, like the contaminated and unfortunate ticket-of-leave men, unpurified and unemployed, to be liberated at a sad cost, to poison and corrupt all around.

So much for the sewage question: now for a few words on the embankment and shore-traffic. It would be impossible here, were it even necessary, to notice the many ideas on this subject the public have had the benefit of, or have been bewildered with; but, of the more recent, it would be a waste of time to discuss

Section, showing part of the River, and one side of the Works proposed.——Scale, 90 feet to 1 inch.



* The *low level* intercepting tunnel-sewer being carried along chiefly under the wharfs, near where the great sewers now discharge, the necessity for and expense of "reversing" the inclinations, to force their discharge into the intercepting sewer proposed at north side, under the Strand line of street, would be avoided, as likewise the danger of bringing down St. Mary's and St. Clement's churches, while executing the sewer at such a depth so near them; while, at the river edge, the cost of the low-level sewer would not be *one-sixth* of the cost of that under the streets, and the *lowest-level* sewer could in most parts be executed in conjunction with it, as shown above.

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the merits, or rather demerits, of a continued esplanade, at the unnecessary height of 35 feet above the river, as has been proposed for a thoroughfare, as it could do nothing for the sewers or sewage, though darkening, destroying, and rendering useless the many offices, stores, and places of business that now look out upon the Thames, though (it is too true) with an unseemly irregularity. Neither shall I waste your valuable space discussing a project, alluded to in the *Builder* some months since, for placing the "lowest-level" drain in the bed of the centre of the Thames,—about a cable's length from the ends of the present sewers, where they discharge! for, if sense and sincerity be not exploded, a moment's thought and calculation would have convinced the spirited projector that the cost of conveyance *to* and removal *from* this great central artery would be fatal to it, even if its construction was *inviting* from its facility and economy, which he ought to know it certainly *is not*.

I trust, Sir, that I have, in some measure, reduced the heads to be considered, to that question I have alluded to, which is,—Where can the *low* and the *lowest level* sewers be placed with most facility, economy, and advantage to the public?

My view, as before stated, is, that the low-level sewer can be best carried along by, or under (as circumstances may require) an improved shore-wharfage, so as in no way to injure, but rather improve, vested rights. The lowest-level sewer I would propose to form as many feet below low water—say 7 or 8 feet—as drainage would require, nearly parallel with and by, or a few yards from, the line of the shore-wharfs, chiefly in the bottom of a series of barge-docks, formerly mentioned; for, between these shore-wharfs and a uniform esplanade, 60 feet wide, which I have recommended, 5 feet (not 35 feet) above high-water, the unnecessary, or rather mischievous breadth of the river, nearly all through from Millbank to Wapping,* would admit of small docks being formed, with arched passages under the esplanade (to be raised in those parts) for the barges to pass in to the existing wharfs and stores—the very raising necessary at those arches, the inclination being easy,—would add much to the appearance and enjoyment of the esplanade, and facilitate the drainage and formation of a good road-surface upon it; while the docks, each secured by a tide-gate, and so capable of being kept either full or empty, would while full greatly convenience the discharge of lighters, and when empty would answer as coffers in which to sink and to construct the lowest-level sewer, which, without this aid, and the facility it would give, there might be extreme difficulty and *danger* in effecting.

I stated formerly that the outer wall to the esplanade, next the Thames, would concentrate, render uniform and more effective, the power of the ebb-tide; and this has been proved on the Clyde, in Dublin harbour, and many other places. And nothing need be feared from a too great rapidity of stream, as the speed would not equal that through London-bridge at present, where the water-way is but 650 feet, while between the walls might be 800 feet, to allow slack-water and "lie-byes" for landings for the river steamers.

The inner side of the embankment† next the barge-docks might be, at first, formed *for* and preserved *by* a rubble beaching of, say 1½ to 1; on which, at any time, a railway 16 feet over the road-level could be carried, connecting all intermediate places and the city with even the extreme West End.

Bazaars and places of business might be erected between the rail and the esplanade, and excellent and attractive shops and houses might be built on either side of the extensions (between the docks) of such several streets as it might be desirable to continue down to the esplanade or to the improved wharfs, to connect them with the Strand-line of streets.

It would swell to too great a length for your pages, this notice of even so necessary and sanitary a work, or rather combination of works (for all should be considered together and constructed together), were I to go more into the details, which really admit of absolute demonstration. But it is only right, on the score of economy, to observe, that without resorting to a toll on the esplanade drive, objectionable though perfectly justifiable, a very large proportion of the whole cost would be provided for by the work itself:

1st. By the rents of bazaars, restaurateurs, and places of business, on the inner side of the esplanade.

2nd. By rent of sites for shops and buildings on the street extensions.

3rd. By barge-dock reasonable charges, and on wharfage for additional accommodation.

4th. By rent or purchase during progress of works, or after, of the railway line to be preserved throughout.

5th. By rent or purchase of superfluous space outside such grounds as Whitehall, the Temple-gardens, &c., to be reserved for ornamental uses.

It will be perceived that I take no credit for any possible profit on the deodorisation and solidifying of the sewage, that being as yet an open question. Although it cannot be denied that, if on the larger scale it can be made as self-supporting as it appears to be on the smaller, or even nearly so, a vast public good would be effected by its adoption—

First, by the dispollution of the tidal waters; and,

Secondly, by the providing a large and valuable supply of manure, though its entire value should be expended in extracting it.

If then a profit should arise, over and above the actual good effected indirectly by the cheapening of food and promotion of health, the public would have the direct pecuniary benefit from it. Therefore, on a careful consideration of the whole river-question, which has nothing to do with the dispute about pipes or tunnel-sewers—(though each has its merit, and I agree with the Sanitary Commissioners in preferring the latter)—the public, who pay, need not be uneasy under the anticipated pressure of the ultimate cost, if the works be honestly carried out and attended to. But they may rest assured, that no project will give satisfaction to such a complication of interests, that does not provide for (each side of the river)

1st, a low-water, and

2ndly, a below-low-water drainage;

3rdly, a uniform river wall;

4thly, an esplanade drive and promenade, connected with the principal streets;

5thly, a railway site parallel to it;

6thly, a series of small docks within the esplanade and rail line, to meet the requirements of the present wharfs and stores, and such improvements of them as opportunity and circumstances may render desirable; and

Lastly,—Provision for an entire deodorisation and solidifying of the sewage, to be effected at once or at any future time.

I am, Sir,

June 13th, 1856. A RETIRED CIVIL ENGINEER.

* At Millbank and at Wapping the Thames is only about 800 feet wide, while between the bridges it is, in places, nearly twice that breadth.

† The excavation from the two intercepting sewers, from the foundations, and from the bed of the river in forming the barge-docks, with little or no aid from outside the wall, by boat or otherwise, would form the main embankment; leaving for the cross-embankments the excavations from the main sewers throughout the city, and all rubbish that might be permitted to be shot there during the progress of the work.

ACOUSTICS.

IF there is one subject more than another that deserves our careful consideration, it is that of Acoustics. The mind, thirsting for intellectual food, is fed by the sense of hearing, in a manner which no excellence of book-writing can ever compensate for or supply. Thus, by the earliest records of the human race, we have traces, at least, of the soul-stirring effects of eloquence upon the ear; and more than traces, in the divine descriptions by the inspired writers; based on which, it was a beautiful and justifiable realisation of Milton's, to pour forth, in such matchless language, the conversations of the angel with our first parent,—re-delivered (softened by that well-appreciated power of the grove, the garden, or the bower, which I may presently have to allude to,) and simplified, by Adam, to his attentive and admiring consort. Then, again, we have been handed down undeniable records of the oral grandeur of a Homer, a Demosthenes, or a Cicero; and although it would be apart from the mere practical consideration of the subject before us, to attempt even the slightest sketch of modern oratory, I trust, however, that it is perfectly legitimate to allude to the exquisite intellectual banquet that has been enjoyed by the reading of a Siddons or a Kemble, or the recitation of a Young, a Knowles, a Macready, or a Kean! All these would have been lost, or but half appreciated, had not places been found or formed, in which they could be heard distinctly by very large numbers of persons.

Then, again, the conveying, I may say the spreading, of the useful arts, is mainly dependent on the facilities for hearing, in the *lecture-room*. The most able professor will be powerless for

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good, if, while the eye dwells even eagerly on his experiments, the ear cannot gather up his address, however eloquent. Then, although the drama, and even the opera, have their attractions for the eye, still they have greater charms for, and are mainly dependent for success on the effects they produce upon, the ear. And the finest concert or oratorio, the most spirit-stirring pulpit address, or the most touching and truthful appeal in a hall of justice, will be lost, unless the most perfect hearing be considered and provided for. Lastly, if the construction of the senate-house be not favourable for hearing, much may be lost, even to members themselves, which it might be desirable and proper that they should reply to. And the public may remain ignorant of the most important matters, even though present, or represented however efficiently by the press, if clear articulation be not conveyed to that public, or to the reporters in the galleries who act for them.

I have thus briefly endeavoured to express how highly I estimate the advantages to be derived from the study and application of the principles of acoustics; and I consider that, on those principles, as far as we have developed them, aided by a study of nature and a consideration of her provisions, there is no structure that could be required for the purpose of large numbers of persons seeing and hearing, that could not be *satisfactorily* contrived, even if not made perfect for its purpose by its form, construction, and completion; and I consider that there is no case of failure so bad, even where it amounts to the confusion and destruction of sounds, that it could not be mitigated and improved, so as to render it satisfactory.

In the investigation of this intensely interesting subject, it may be instructive to consider, first, some of the aids which we may derive from Nature—animate and inanimate; and, secondly, it may be useful briefly to allude to, as warnings, a few cases of failure, and the aids (or rather confirmation of the principles) derivable, on the other hand, from artistical or accidental successes,—with a practical application or exemplification of the principles derivable from all.

Our first aid may naturally be taken from the construction of the ears of the most sensitive-hearing animals, such as the horse species, the hare, rabbit, cat, &c.—take the cat, as the most familiar, and therefore the easiest investigated. The alcove, or cell, in which puss receives every scintilla of, to us, unappreciable sound, is not a bare receiver of sound—as builders, generally, seem to have considered their structures should be—but it is a *hopper*, as it were, not only contrived to *receive* a supply of the mere sound, as ample as the animal can with convenience bear, but clothed with *interceptors*, softening, refining, and retarding it, in order to its being more accurately and satisfactorily distinguished. This interception is performed by the thin hairs and downy surface observable on the semi-polished interior of those leathery appendages of such animals, and with which the donkey is so liberally provided.

I have no doubt that many naturalists have observed this circumstance, and also that exquisitely fine hearing mainly depends on this delicate *interception*. That such animals do possess a perfection of hearing most extraordinary, it may not be out of place here to relate an anecdote of the cat, which has been well authenticated. Some travellers in Egypt having met near the Great Pyramid, they considered it would be very desirable to have it ascertained, and absolutely proved if it were practicable, whether there was a passage or opening in the interior, from the top to the bottom of the structure; accordingly, they offered a reward, equivalent to about twenty pounds, to any one proving satisfactorily that which they desired to know. After a delay of some days, an Arab came forward, and undertook to perform the service, "no performance no pay." When the morning arrived that he was to commence this seemingly dangerous and laborious feat, his tools and assistants were eagerly looked for,—but his reliance to unravel the mystery was upon his favourite cat and her kittens! The latter he fastened into the lower part of the stupendous structure, and then, with pussy under his arm, ascended to the top of the vast pile, at a small opening in which he introduced her, and securely closed the aperture. Enjoining the most absolute silence, he descended, and placing his ear to the closed orifice below, he could hear the cries of his little allies, cries which were doubtless soon heard in the desired quarter. The mother's ear intercepted and distinguished the cry of her children at that incredible distance—perhaps, with obliquity and sinuosity, above one thousand feet! may be, twice that if the cat could tell her story; but no duet was ever performed more true to nature's harmony than that which greeted the ear of the Arab between the kits on the one part and the cat on the other, until, removing the stopping, he took out his feline helpmate,—her hair, however, somewhat dishevelled by her exertions in the cause of antiquarian research,—and presented her to the savans as the winner of the twenty pounds, which was cheerfully paid to him.

I shall now give an instance of the evil of *non-interception* (as can be easily proved by any person desirous of doing so), but which nearly cost me my life, and for a time almost deprived me of the use of a valuable horse. A groom in embryo, then performing the functions of an exercise-boy, had often observed the nice finishing touches bestowed by an excellent servant on the horses in his care, and, not to be outdone, one day, having the stable to himself, he removed carefully and neatly, with a small scissors, the whole of the downy "interceptors" (as I call them) which nature had provided in the horse's ear; the consequence was, on the approach of a vehicle, or any noise, particularly from the *rear* (and all have observed how these animals can turn back their ears to listen), the horse became panic-struck and nearly ungovernable,—to a stranger he would have been perfectly so. He undoubtedly received, but with a crash and confusion, the quantity of sound proper for him to receive, *but he had lost the power of softening and detaining it, while he was distinguishing it.* Time only, restoring the downy hair to his ears, cured the affliction. Like the visitor to the whispering-gallery at St. Paul's, he had heard more than his ear could *digest* (if I may use the term), and the result was a shock and a fright; but it demonstrated to my satisfaction, on that point at least, the value of the *interception of sound.* But as this horse lost no more than the power of interception, it may not be amiss to mention a case—even though it be an extreme one, not likely to occur in this animal-protecting age—where a horse had lost not only the power of intercepting, but of receiving collectedly the sounds from without.

An esteemed friend and good sportsman purchased a hunter, otherwise of much value, under price, in consequence of disfigurement and great laziness. The poor animal had the misfortune to have lost his ears, close off to his head,—that part of them intended by nature to receive sounds, and to contain the means for intercepting and distinguishing them. We need not inquire here how the ears were destroyed; it might possibly have been by a violent mode practised then, to aid the cure of the button farcy (a disease curable, but having something in common with, and quite as bad as glanders), by sewing up, for a certain time, a strong preparation in the ears of the animal. In the case alluded to, the ears were obviously and undeniably gone, so that it was with difficulty a bridle could be kept on him. What was the the effect of the mutilation? The inspiring cry of the hounds, the ring of the horn, or the "Away!" of his master, were all lost upon him, or, if heard, could not be distinguished from any other quantity of confused and partially lost noise. Although he had still the *inner* receptacles of sound I shall presently advert to, there was a stolid, stupid apathy, an insensibility to sounds which it is known excite horses, when possessed of their natural perception, or *interceptions*, to a degree of intoxication dangerous to inexperienced riders. Although a fine and a good horse, he was so downright lazy and indifferent to everything around him, that nothing but what appeared a pitiable application of the whip and spur could keep him in his proper place, which he was so well able to maintain.

I shall now make a few observations on those *inner receptacles of sound*, above alluded to. I think this the more necessary, because the animal case just mentioned shows the futility of even cellular receptacles for sound, unless aided by something in the way of collection and interception, although in many buildings we find them stand naked and unassisted, like those on the earless horse. Any person may observe in the cat, or in any of the animals I have mentioned, the admirable provision of nature for the *reception* of the collected sounds, after they have been stayed and softened by *interception*. The interior of the ear within those interceptors is not a mere hollow dome or cell; it is a cellular, or many-celled and semi-polished concave surface, it may be said, surrounding the aperture leading to the interior of the ear. This cellular construction I consider as valuable for its purpose as the interceptors are for theirs, and I shall allude to it again when I come to the practical and mechanical application of what I have advanced.

Inanimate nature next affords very valuable instruction and information, proving still more strongly, that although the inter-

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ception of sound may be considered a *sine-qua-non*, the reception of it, independently of its value beyond or as a means for interception, is a matter of almost if not total indifference,—although it is too commonly relied on as the sole and only provision in aid of hearing, in the most extensive structures built for audiences.

Any person who has been in a wood, on a still day, may have observed, by a little attention, that if there be an axe or hatchet in use within an area say of one hundred acres, and causing ever so little noise, it may be heard—and why? because the trees, the branches and the leaves, are most perfect interceptors, while they are sufficiently hard and smooth, or "semi-polished," to be non-absorbents of sound; yet they cannot be said to be *receivers* at all, for the sound is nowhere stopped, but may pass (after its interception) out of the wood at its margin all round. Here, then, is an area, say of one hundred acres, on which three millions of people could stand, where, by nature's contrivance, the whole population of London, if quiet enough to listen as one man, could hear simultaneously the stroke of a small hatchet!—Why cannot we do something like, however immeasurably inferior, to this?

A word more on nature:—Who has not heard of, if he has not felt, the silence of the desert?—arising, as it is easy to prove, from the absence of objects capable of intercepting the sound. I have known a glee to be attempted, but rendered impracticable in such a place; and obviously from the above cause alone, for no sooner had the party reached the margin of a wood, than in one of its umbrageous recesses they received their voices again, and the harmony pealed forth from nature's orchestra with more than usual grandeur and beauty.

Lastly, on deductions from nature:—Who has not observed that the reflection of sound, or echo, is most perfect when the music, voice, or cannon, is directly opposite or at right-angles to the surface from which the echo proceeds; and so in proportion? Thus are produced the wondrous echoes of the far-famed Killarney. The bugle or cannon is placed directly opposite some extended surface of rock, as at the "Eagle's Nest," or of trees, as at "Glena;" and the reason of the sublime and continuous repetition of such sounds at those places is, that from the unusual sinuosities or cellular formation of the surrounding woods and mountains, there are an infinity of *intercepting* surfaces, at about the proper distance, and facing, at right-angles or nearly so, the rocks or woods from whence the first, second, third, or following echoes proceed,—aided, no doubt, by the extensive and tranquil lake-surface as a conductor.

I had prepared some further remarks and a series of deductions from the facts and observations I have in part laid before the reader, but want of space precludes their insertion this month; in the next I shall gladly resume the subject.

J. W., *C.E.*

261, *Strand, June 25th*, 1856.

PRINCESS'S THEATRE.—THE "WINTER'S TALE."

In keeping with the progressive features of the age is the care and attention so generally bestowed on the several departments of theatrical art. It is not deemed sufficient for a series of set scenes and dresses to constitute "properties" available for illustrating any period or country, nor is the Macbeth of yore personated, as our not very remote ancestors were wont to see him, by the excess of refinement, in a bob-wig and court suit, but each revival or production of standard excellence is ushered in with really "new and appropriate scenery and decorations." To assist in the completeness of such productions, managers wisely consult special authorities on various points, and thus the stage becomes not merely a platform for the display of action and sentiment, but serves also to exhibit in the strictest sense "the very age and body of the time."

Among the earliest promoters of this movement is the lessee of the Princess's Theatre, who, in the gorgeous pageants he has from time to time presented to the public, has spared no labour or expense to render them as nearly as possible consistent in themselves, and instructive as bringing them to bear truthfully, as far as practicable, on the historical circumstances involved. In the play of the "Winter's Tale," the last revival, and one that promises to be duly appreciated, evidences of this care are manifest throughout. To avoid anachronisms and other inconsistencies in the original text, numerous alterations have been necessary, but these changes have afforded opportunities of introducing, from authentic sources, details with which the majority of persons are unacquainted, and they give a most important insight into the private and public life of the ancient Greeks at a time when the arts flourished to a perfection the scattered vestiges of which still delight and instruct the world. Among these, Architecture of course is not forgotten, and ancient temples and monuments form conspicuous objects in the various landscapes. The surpassing beauty of the opening scene, which shows on a lofty site the Temple of Minerva at Syracuse, a stately Doric building, and in the foreground the Fountain of Arethusa (restored), will be acknowledged by all. Some peculiarities of design may be observed in this "fountain," viz., the proportions of its parts and cornice, and the omission of the cyma in the raking lines of the pediment, which are terminated by scrolls in place of acroteria. Whether this be an innovation or a faithful rendering, the effect is not good, for the crowning moulding is wanted to balance and complete the whole. Passing on to the second act, we are introduced to the "Court of the Gynæconitis," or women's apartments, the perspective of which is too foreshortened to look natural, and evidently strained so as to disclose a bit of blue sky, showing that the place is hypæthral. The artist too, in his wish to secure brilliancy, has been as sparing in natural shadows as lavish in reflected lights; some of the latter are very contradictory. A much better painting is the following one,—the famous prison known as the "Ear of Dionysius," and one of the Latomiæ or prisons of Syracuse. Its natural as well as constructed capabilities were such that conversations and confessions held within were clearly audible in certain other parts of the interior, owing to a peculiar reverberation. The rugged character of this spot is capitally depicted, as is also its gloomy distance. Next, "A room in the palace at Syracuse, with a view of part of the city," is cleverly depicted; the wall tapestries are noticeable as being ornamented by designs taken from some of the richest vases discovered in the south of Italy. In the next scene, representing the trial of Hermione in the public theatre, we find an ingenious combination of the real and the artistic. The conception and treatment are alike praiseworthy, and convey the impression of a vast and thronged area to a very illusive degree. Passing over some minor portions of the design which might have been better, we must bestow an approving word on the design of the "*Ark*" in which is borne the oracular decision from Delphi; it is exceedingly tasteful and, with its tripod and other accessories, in excellent harmony throughout.

"A room in the palace of Polixenes," in the fourth act, is curious from the several articles of furniture brought together, but which we should characterise rather as fantastic than simply useful,—the chair especially. Omitting any allusion to the stage effects of the classical allegory which is introduced to represent the course of Time, with Luna in her car, and also Phœbus, we cannot but notice the landscape beauties of "A beautiful scene in Bithynia," which comprises a distant view of the city of Nicea, on the lake Ascania, and a chain of lofty mountains known as the Mysian Olympus, forming altogether a charming composition.

In the "Garden of Leontes," with which the last act opens, as well as in the next scene, showing the "Tombs of Syracuse," the buildings are all strictly architectural, and, like the previous ones, wholly of Doric character. Perhaps a little more diversity in their composition would have been better; we can hardly suppose that so great a monotony prevailed of old, or that one not very pure feature, inasmuch as it is at variance with the recognised massive principles of the Order, should have so generally obtained;—we refer to the distyle porticoes, which, in every instance, are shewn much too spreading, the intercolumniation-space being nearly as wide as high. Independently, too, of the violation, this arrangement entails a degree of squareness in the general outline which is very unprepossessing.

The statue scene is of course replete to its minutest portions with careful study, and though (judiciously) exhibited as by torch and moonlight, every part tells well and contributes to the *tout ensemble*. Apart from the acting of Mrs. Kean, the merits of which it is not our province to discuss, we would draw attention to the exquisite series of folds which her white drapery assumes, according to the different gestures of the body, and so surprisingly effective from the strong and reflected lights thrown upon it. It formed an appropriate finale to a work in which both adapters and artists have done themselves much credit; and, realising as it does, from the best resources extant, the events attempted to be illustrated, it is one which the public at large will do well—if only for the sake of the information to be derived—to take an early opportunity of witnessing.

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THE ARCHITECTURAL EXHIBITION.

The exhibition will be opened to the public in the Suffolk-street Galleries on the 17th day of December next, and will remain open till nearly the end of February. All works must be delivered at the galleries on the 1st or 2nd of December, and none will be received later. Two rooms, as before, will be retained for models, carvings, decorations, specimens of manufactures, and inventions connected with building, and as the committee have ascertained beyond a doubt that most of those who have been exhibitors on former occasions have reaped a substantial advantage—have found it most profitable, and the very best mode of making their productions known, not only to the architects and builders of London, but to those also of the country at large,—they will on future occasions expect all to pay a sum according to the space they occupy.

REVIEWS

Observations on Hop Drying; being an attempt to reduce the different modes now in use to a general system: with a description of a new and economical apparatus. By S. Egan Rosser, C.E. London: Richards, Great Queen-street.

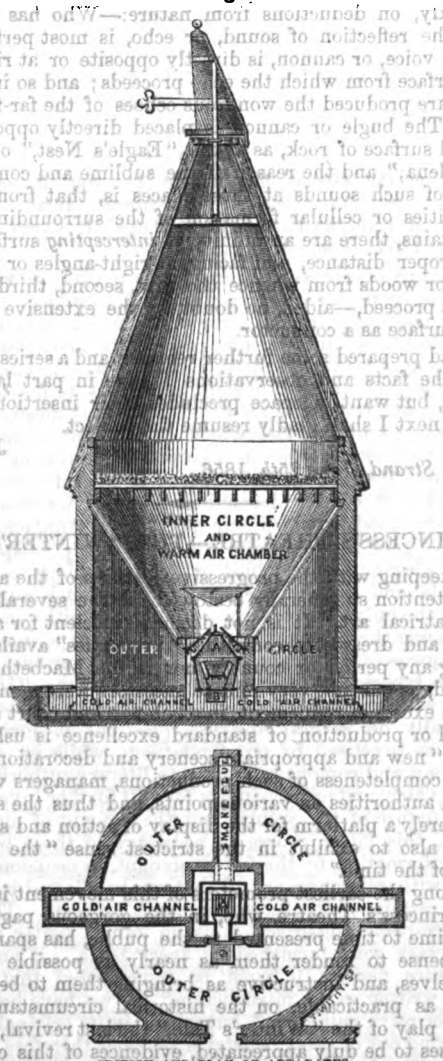
Among the multiplied applications of science, none are more useful or important than those which are brought to bear on the conveniences or comforts of everyday life. The wondrous developments of machinery, and the more subtle discoveries of chemistry are alike subservient to this end; the one lightening, while increasing, labour, and the other constantly presenting some fresh antidote to toil in the production or preparation of articles of consumption, essential to the healthy maintenance of the bodily powers. The value of the hop, as an article of trade, needs no comment; it is sufficient to point to the large districts of England which are wholly devoted to its cultivation, and the extensive uses to which it is applied. Proportionate to the utility, therefore, must be the advantage of its being sent into the market in as pure and perfect a condition as possible. Now, the inadequacy of the several modes hitherto employed for drying hops is clear from the various schemes which have been adopted, none of which, it would seem, are altogether satisfactory. With a view therefore to remedy, as far as may be, the defects in the present ordinary method, Mr. Rosser, who, by his own works, and formerly as connected with the late Mr. Sylvester, is favourably known as an engineer, proposes some modifications, the purpose and working of which are explained in a treatise which we can recommend to those interested in the subject, as exhibiting a practical and practicable plan, meeting, it would appear, most of the wants of the case.

Hop drying is a process of desiccation, of which the object is to drive off the superfluous moisture from the hops. This may be accomplished by either of two ways, one by exposure to the wind or a current of air, and the other by exposure to a high temperature in comparatively still air. The completeness of the process, and the time in which it may be effected, depend, however, upon the circumstances under which it is performed. Treating hops simply as a substance from which a given quantity of moisture is to be evaporated, that object would be most speedily effected by admitting as much air as possible at the highest attainable temperature. But there are certain peculiar properties attributed to the plant, which are liable to be destroyed when subjected to a heat beyond a certain point; hence arises a conflicting difficulty, and a question how nearly the balance can be adjusted. The operation by which hops are deprived of their moisture, and reduced to the state in which they are known to the brewer, has generally, like most other processes in the arts, been carried on in the rudest manner. The attempts of individuals to obtain improved results, though often more or less successful, have but little benefitted the body of hop-growers, because it has commonly happened in such experiments that success depended upon some unnoticed peculiarity, while the general and obvious features of the arrangement, when repeated by themselves, have failed in producing satisfactory results.

It is the object of the little pamphlet before us to eliminate, as it were, the essential elements of success from a variety of the best examples, and then to deduce, upon scientific principles, certain rules generally applicable in the construction of the kilns in which hops are dried, and to develope the best form of apparatus for desiccation.

The author recognises, in the *liberal introduction of air into the kiln*, the basis of a successful system of hop-drying. Desiccation may be conducted either at high or low temperature, but it has been found that with reference to hops, a comparatively low temperature is the most favourable. For constructing kilns, the questions for consideration are:—1st, the quantity of air necessary to be admitted; 2nd, the mode of its admission; 3rd, the method of heating the air; 4th, the proportion and construction of the kiln necessary to give a full effect to the above arrangements.

Under the first, second, and fourth heads, the architect who is engaged in the planning of kilns will find various observations which may guide him as to the details of the scheme. The method of heating the kiln has generally been accounted as the most important point connected with hop-drying, and under this head the author describes an apparatus by which very large quantities of air may be heated without over-doing or burning the air. This object is intended to be accomplished by a large extension of the diffusing surfaces as compared with that upon which combustion takes place. The peculiarities in the construction of the improved apparatus are stated to be—1st, the situation of the fire in the centre or heart of the stove, at a distance from the outer surfaces, which cannot, therefore, become heated to the extent which takes place when the mass of fuel is in direct contact with the sides; 2nd, the exceedingly small size of the fire-grate, as compared with the area of the firebars, either of open fires or of ordinary cookles, and consequently a diminution in the consumption of fuel. Other points are noticed, and the section of the stove described at length.



SECTION AND PLAN OF APPARATUS

The internal construction of the stove is such that almost all the useful effect of the fuel is absorbed before the smoke and

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gases leave the body of the stove. In the first place, we have in the pyramidal top a very large surface exposed to direct radiation, and the flame and smoke being compelled to turn over the upper edges of the fire-box, and to descend between it and the outer casing, a large portion of heat is imparted to the sides of the stove. The smoke then continuing its descent, heats the bottom of the stove, and the outlet flue upon which the stove rests. The heat of the smoke is thus so thoroughly exhausted, that with well-managed fires the temperature of the bottom of the stove does not exceed that of boiling water. There is therefore no necessity for any horizontal flue beyond that required for connecting the stove with the chimney, and this portion of the flue will generally be under ground. The external construction of the stove is the feature by which its efficiency is mainly distinguished. Besides the opportunity afforded the air to abstract heat rapidly, from the large extension of surface, the course of the air, from the point at which it first comes in contact with the stove to the point at which it leaves it, is accurately prescribed, and a perfect contact of the particles of the air with every portion of the heated surface positively ensured. The channels by which fresh air is admitted are brought in under the bottom of the stove, so that the cold air first impinges upon the outlet flue and the bottom of the stove, which are the coolest parts of it. This principle of bringing the air, as it becomes warmed, into successive contact with still more highly-heated portions of the stove, is pursued throughout, and means of a simple description are provided in the stove for regulating the draught and sweeping the flues. Thus the saving in fuel must be an important item.

Many of the observations in the pamphlet would probably be useful in the desiccation of other substances, and it seems to us that the apparatus would be of service also to the maltster in the process of malting, and possibly to the manufacturer for the drying of yarns and fibrous matters, as well as for ordinary laundry uses.

Handbook of the Arts of the Middle Ages and Renaissance, as applied to the Decoration of Furniture, Arms, Jewels, &c. Translated from the French of M. JULES LABARTE. London: Murray. 1855. 8vo. [Second Notice.]

In the limits of our previous article (see p. 210), we were unable to do more than introduce generally the subject of revived mediæval art, and point out some of its modern misapplications in principle and detail; we now resume the matter with a view of explaining, by the aid of M. Labarte's work, some of those choicer relics of antiquity which in various forms have come down to us, and the study of which is the best means of appreciating those latent beauties which our present artificers either have too little knowledge or means of impressing on their productions. Perhaps every branch of handicraft art should not be included in this latter detraction;—pottery for instance, and the exquisite models which our porcelain manufactories have issued, have gone far to elevate the taste and predisposition for pure and elegant forms joined with harmonious colours and enrichments; and some of the reproductions—it is a pity that as yet this is the only suitable term—of our goldsmiths and jewellers are evidencing the practical results of patient experiments, in the delightful gems of art-production which meet our eye. Now it is to such laborious students as these that the "Handbook" before us will be of the greatest service, for it treats minutely and carefully on several abstruse questions of materials and their use, as practised by our forefathers, while an abundance of engravings and copious references to literary authorities stamp additional value, and open channels for still further investigations. From the nature of the volume and the amount of matter to be condensed, this latter course is necessary to those who would turn the information to the fullest account, as occasionally a few sentences with references are all that can be allotted in the elucidation of certain of the most important subjects. Thus, while in some respects imperfect, it is in others better than if a complete essay were furnished on every topic. If any further apology were needed, it must be remembered that "it was originally written as an introduction" (as we have before cited) "to a descriptive catalogue," but which in its original language has been long out of print; whatever portions therefore related to the main scope, have been divested of their immediate reference to the Debruge-Dumenil collection, and translated, with such supplementary matter as could be obtained, to form a volume it is to be hoped not without interest and use. Its value, we are informed, is already acknowledged by French antiquaries and artists, M. Didron among others; and M. de Laborde states that, "L'ouvrage de M. Labarte est dans toutes les mains; il serait inutile d'en faire l'éloge, il est dans toutes les bouches."

The first chapter is devoted to a treatise on "*Sculpture*," in ivory, wood, alabaster, marble, various sorts of stones, wax, metals, and cameos, of each of which a concise explanation is given, and a historical thread is preserved so as to enable the reader to note the developments of successive periods. Take as a specimen the following, under the head of Diptychs:—

"The most numerous specimens that have reached us of mediæval small sculpture, consist of diptychs and triptychs of ivory.

"These diptychs are of very early date. They were formed originally of two little tablets of wood or ivory folding one over the other like a book, the interior of which presented a surface of wax prepared for writing. Hence the names of διπτυχα, and of *pugillares*, the former bestowed on them on account of their double fold, the latter with reference to their small dimensions, which allowed of their being held in the hand or *fist*. These tablets were tied round with linen threads on which wax was melted, and impressed with a seal, and they thus served for conveying secret messages.

"The diptychs were soon employed for a more interesting purpose. From the time of the emperors, it was the custom for the consuls and superior magistrates to make presents of ivory diptychs, carved externally with sculptures in bas-relief. These they sent to their friends to preserve the remembrance of their elevation, as well as to the principal persons who had voted in their favour, and also to the governors of provinces. On these diptychs was generally represented the person of the consul arrayed in his official robes, with inscriptions setting forth his names, his titles, and the denomination of his ancestors: and frequently the games of the circus with which he had amused the people at the period of his elevation to office.

"These are known by the name of *consulares*, and although very interesting, must be passed over, belonging rather to the latter times of antiquity than to the middle ages.

"At a later period, when the Roman empire had adopted the Christian religion, the consuls sent diptychs to the principal bishops also, and these receiving them as a testimony of good-will and respect to the Church, placed these diptychs upon the altars, that the magistrate who gave them might be recommended to the prayers of the congregation at the celebration of mass. Such is the origin of *ecclesiastical* diptychs, divided by Gori into four classes: 1. Those on which were inscribed the names of the neophytes, or newly-baptised; 2. Those which received the names of benefactors to the Church, of sovereigns, and bishops; 3. Those which recorded the names of the saints who had edified the Church by the glory of their martyrdom or the lustre of their erudition; and lastly, those upon which were inscribed the names of the faithful, clergy and laity, who had died in the bosom of the true Church. The subjects of the carvings which enriched the exterior of these diptychs, being taken from the New Testament, they appeared, after the fall of the empire, very suitable for decorating the covers of books of prayers, to which use we owe the preservation of a great number.

"During the persecutions of the iconoclastic emperors, the Greek artists produced a great number of portable sculptures, and multiplied in the diptychs, and small pictures with folding leaves, doors, or shutters (*a volets*), all these images and paintings so odious at Constantinople, and which thus escaped the universal proscription.

"When the persecution had ceased, the use of these pictures was universal, and continued in succeeding centuries. The crusader, the traveller, the poorest pilgrim, enclosed in diptychs and triptychs of wood and ivory the holy images he devoutly carried with him, and before which he daily prostrated himself to offer his prayer to God. Some were also made of large dimensions, and placed over a 'prie-dieu,' or devotional chair, in private rooms."

Iron, also, has not escaped the chisel of the sculptor. It was principally in Germany, in the second half of the sixteenth century, that this branch of art was cultivated, and Augsburg was particularly celebrated for its productions. Large works were made in France, too, about that period; among others, the fine gates of the gallery of Apollo in the Louvre. Hammered or "*repoussé*" work—in which the sheets of metal were beaten out to the forms the artist wished to produce, with the figures or ornaments in relief on the surface—may be traced to remote antiquity, being described at least in principle by Homer. It was chiefly employed in the making up of armour, but frequently in bas-reliefs, statues, and vessels of gold and silver, which were first worked in "*repoussé*" and afterwards chased.

From "sculpture" the author proceeds to "painting and calligraphy," which is traced back to the decoration of MSS. by the Romans, and subsequently by mediævalists. The most ancient specimens of calligraphy extant are probably the Terence of the

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fourth century, and the Virgil of the fifth, in the library of the Vatican.

"To date from 1150, a new and happy impulse began to be felt. Drawing acquired precision, firmness, and a certain truthfulness of expression. Nevertheless, a black stroke marks the outlines, defines the form of the principal details, and limits throughout the various tints of colour. The fanciful ornaments, the grotesque figures which, mixed with foliage (*rinceaux*) and interlacings (*entrelacs*) surrounded the initial letters, and often formed the sole decoration of the books of the preceding century, now began to be discontinued; the calligraphic borders are not so broad.

"From this period, artists cease to borrow from heathen art; and take nature for their guide. Their ornaments are derived from the vegetable kingdom, and their figures, with the exception of Christ, the Virgin, and the Apostles, are all attired in the costume of the time. Gold is still generally employed in the ground.

"Painting continued to progress until the end of the thirteenth century: but the drawing, in which the outlines are too strongly marked, is apt to be hard and stiff. The gold grounds begin to be replaced either by grounds of colour diapered with patterns of gold, or by grounds representing an iridescent mosaic, which has a very pretty effect.

"Painting, towards the beginning of the fourteenth century, exhibited a marked improvement. The pen is no longer in requisition for determining the outline of the drawing, the brush alone is employed; the *motives* are full of grace, and the execution, although still timid, is always finished."

The art of painting on glass and in oil is next discussed, but it is a field on which we need not here enter. (A separate chapter is after allotted to glass manufacture.) Mosaic painting, by which a design is produced by the combination of small pieces of hard or hardened substances, naturally or artificially coloured, was practised by the ancient Asiatic nations, and also by the Greeks, who transmitted it to the Romans:—

"It was originally designed for the decoration of the pavement of buildings, but it soon sought to rival oil painting, and usurped its place in the embellishment of walls, and the vaulted ceilings of churches.

"When the Christian religion, under Constantine, was triumphantly installed in the Roman empire, she accepted mosaic as the principal art for the decoration of the basilicas. The Greeks enriched this art with new processes, and with their love of ornament, they devised a method of introducing a ground of gold and silver leaf under the cubes of glass, by this means shedding over the large works of the artists in mosaic a splendour before unknown.

"The church of St. Mark at Venice, with its series of mosaics, is still an incomparable museum, in which may be easily traced the progress of art, and the various changes of style, beginning with the eleventh century."

The various processes of enamelling, Damascene and Limoge work, champ-levé, and the like, form the basis of a very useful and instructive essay, than which we nowhere remember a better within a similar compass. We should willingly make extracts, but that it is difficult to select, the whole subject being more or less involved.

Scarcely less valuable are the remarks on the "lapidary's and the goldsmith's art," and they are equally informing, since the difficulties in constructing anything like a systematic history have been rarely attempted to be mastered. One ought never to write the history of an art without access to the monuments it has produced; but this rule cannot possibly be adhered to in giving the history of the goldsmith's art in remote periods. The richness of the material has occasioned the loss of many artistic treasures, and but few pieces have escaped falling a prey to the cupidity, the necessity, the repeated disorders, of so long a course of centuries, while fashion, that goddess of change, whose destructive worship belongs to every age, has contributed even more than these combined causes to the breaking up of the finest specimens of the goldsmith's work. Articles of this class were much esteemed by the ancients, as may readily be gathered from their writings, as well as from such specimens as have descended to us. But little remains of goldsmith's work of the middle ages. "The only pieces handed down to us are three or four vases of silver, preserved in the Museum Christianum of the Library of the Vatican, the sword and some mantle ornaments found in the tomb of Childeric, and a few others." France, on her part, continued at the end of the sixth century to cultivate successfully this kind of work, and Limoges appears to have been the principal centre of industry. And, at another period, when Charlemagne wished to restore the cultivation of the arts in the vast empire he had subjected to his sway, he found in the goldsmith's departments artists ready to carry out his views. The churches were abundantly provided with vessels of gold and silver, while princes and bishops rivalled each other in the magnificence of their gifts to the basilicas, restored and embellished by the orders of the powerful emperor. Italy followed the example, as the altar at the church of St. Ambrose at Milan will testify; and a taste for objects in metal work became gradually diffused throughout Germany, under the auspices especially of Willigris, archbishop of Mayence, and Bernward, bishop of Hildesheim. It is, however, only the inspection of existing specimens, or at least of good drawings, that can serve to give any exact idea of the brilliant metal-work of these periods. At the beginning of the fourteenth century, art emerged from the cloister, and took a wider range; the goldsmith's skill from that period was no longer employed exclusively in the service of the church, but in that also of rich and noble individuals.

"It would be very interesting to possess in the present day some of those fine pieces of gold and silver plate, with which the table and the 'dressoirs' of the nobility were then loaded, but all has disappeared, and we do not know of one specimen remaining; it is but seldom even that we meet with those jewels which they used for enriching their clothes and decorating their head-dresses.

"It is, however, easy to conjure up visions of all these riches by means of the very detailed and well written inventories of two of the richest princes of that age: Charles V. and his brother, the Duke of Anjou, King of Naples and Provence. The inventory of the Duke of Anjou especially, possesses this remarkable peculiarity, that, although very voluminous, it is dictated by the prince himself, drawn out by him, and signed with his hand.

"Nearly all the churches of Germany were despoiled of their specimens of the goldsmith's art at the period of the wars produced by the Reformation. Yet there still exist in the treasuries of some cathedrals, as well as in the museums, many pieces that show that the Gothic style was invariably adopted by the goldsmiths until the first year of the sixteenth century. Thus, in the treasury of the cathedral of Ratisbon, we see a silver statuette of St. Sebastian, which appears to belong to the fifteenth century, and bears, like those described in the inventory of Charles V., relics suspended to a chain. In the Chamber of Arts at Berlin, there are several pieces of ecclesiastical metal-work of the end of the fifteenth century, especially a statuette of the Virgin executed by Henry Hufnagel, a goldsmith of Augsburg, in 1482. These pieces bear the impress of the Gothic style."

In the mention of eminent artificers (p. 242) Brunelleschi, Luca della Robbia, Mazzano, Antelotto, Nicolò Bonaventura and his nephew Enrico, and the Florentines Arditi, Ghiberti, and Cellini are worthily quoted. The enumeration of their names is sufficient to recal to the memory some of the grandest and most delicate conceptions that have emanated from human ingenuity.

"Goldsmith's work of the sixteenth century, either French or Italian, is very rare, but the museum of the Louvre possesses some fine specimens. Jewels, notwithstanding their perfection, have been unable to withstand the fatal influence of fashion, and have been destroyed in the seventeenth century, and more especially in the eighteenth, during the reign of Louis XV. The public collections in Italy either possess none, or do not exhibit them. In France, with the exception of some mountings of cameos in the Imperial Library, the museums are quite destitute of jewellery. There are some fine specimens in the Cabinet of Antiquities at Vienna; but the jewels contained in the other collections of Germany belong to German art of the seventeenth and eighteenth centuries, rather than to the period of the Renaissance.

"Nuremberg and Augsburg became, in the sixteenth century, the principal centres of the goldsmith's art in Germany. At a later period, Dresden, Frankfort-on-the-Maine, and Cologne, alike produced skilful goldsmiths. The goldsmiths of Nuremberg preserved in their productions, longer than those of Augsburg, a certain feeling of German art; but, in the second half of the sixteenth century, the productions of the German goldsmiths are so confounded with those of the artists of Italy, in everything relating to the execution of figures, bas-reliefs, and ornaments, that it would be very difficult to distinguish the one from the other, were it not for the form of the vases, which almost always preserved a stamp of originality. Moreover, nothing can be more graceful than the arabesques which enrich the German metal-work of that period, nothing more exquisite than the little twisted figures that form the handles."

The subject of "pottery," or vessels of baked clay decorated by modelling and painting, is next brought under consideration, as an art held in honour from the earliest ages. The several modes of preparing the clay among different nations, and the methods of enamelling and varnishing, are clearly treated of, including those by the Arabs in Spain (as exhibited in the celebrated Alhambra vases), and the works of Luca della Robbia and his successors; after which a succinct account is given of the manufacture of stoneware in Flanders and Germany, and of porcelain in China. The Portuguese first imported this latter

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material about 1503. It was a pottery very different, and very superior to all that the Keramic art had then produced in Europe. It was characterised by a hard, compact, fine, impermeable paste, and above all by translucidity; a quality which distinguished it essentially from all other pottery before known. Accordingly, from its first appearance, it was eagerly sought after by princes and nobles, and was, in the third quarter of the sixteenth century, already so extensively used that its introduction was one of the causes which led to the decline of the *majolica* manufactures in Italy. Long sea voyages were not at that time so easily performed as now; the Portuguese and Dutch alone frequented the Chinese seas, and porcelain maintained a high price. After the lapse, however, of nearly 100 years, the art of making a substance entirely artificial, having none of the real constituents, though with all its appearance, was discovered, and first practised at St. Cloud, in 1695, and to this we are ultimately indebted for the Sèvres manufactures, now so highly esteemed.

The qualities of various kinds of *glass* are next considered, and the methods of its production, enamelling, and surface decoration, fully described. Some curious information, too, is given regarding Venetian skill, in the imitation of ancient mosaic glass, also as to the modern productions of Germany and Bohemia.

"*Armourers'* work" is necessarily almost exclusively confined to metals, and the author engraves some elegant adaptations of it in the ornamenting of fire-arms, powder-flasks, &c. *Locks* and *Watches* form a kind of supplementary chapter on metal work, with some very good illustrations; after which we have a few pages on "ecclesiastical and domestic furniture," which we regret to say are needlessly meagre, both as to information and interest. Without trenching too much on other well-known volumes, it would have been easy to glean sufficient to furnish a much more complete epitome of the subject than is here given. As a matter of research, more care has evidently been bestowed on the concluding portion of the volume, devoted to "Oriental art," and it is really an excellent and comprehensive digest.

From the extracts we have thus made from this "Hand-book," and our remarks, it will be inferred that it is to be reckoned more as a work for reference than continuous reading; it almost bears on the face of it the stiffness of a translation. Then again, as before hinted, it hardly comes up to the expectations which its ample title would warrant, since some branches of mediæval art are wholly passed over; still, we can altogether commend it as an acceptable companion to the more elaborate works of Sommerarde, Gailhabaud, and our own Hudson Turner.

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1. *Manual of the History of Art.* By FRANZ KUGLER. Third Edition, thoroughly revised. With Illustrations and Portrait of the Author. Stuttgart: Ebner and Seubert. 1856. XVIII. and 382 pages. Price 6*s*.
2. *The History of Architecture.* By FRANZ KUGLER. First Volume. With 169 Woodcuts, and three Plates in 8vo. Stuttgart: Ebner and Seubert. 1856. X. and 574 pages. Price 9*s*.
3. *Monuments of Art, with regard to its Development from the Earliest Time to the Present Day.* By A. VOIT, Professor at Munich; ERNST GUHL, Ph.D., and Lecturer at the University of Berlin; and JOSEPH CASPER, Member of the Royal Academy of Arts at Berlin. Three Vols. in 4to.-fol. Stuttgart: Ebner and Seubert. 1851 and 1853. Price 3*l*. 10*s*.

The above three works may be said to complete each other. The former has already become a standard work in German literature, as containing the most undisputed results of those deep and manifold investigations that have borne upon the subject. The manifest design of the author is to point out the strict connection of architecture with other arts, according to their different periods, and thus to retrace those relations to the remotest degree. The present first volume contains the following eleven subdivisions:—Primary Degrees of Art; Ancient Egypt; Ancient Central Asia; Phœnicia and Israel; Pelasgian art; Hellenic period; Roman period; the art of the Primitive Christians; the reigns of the Sassanides and Indo-Scythians; the art of the Hindoos and its branches; the art of the Mohammedans.

The second work relates essentially to architecture. The present first volume treats of the architecture of ancient Egypt; of the ancient nations of Central Asia; of Phœnicians and Israelites; of the Pelasgian period and its branches; of the Hellens, since the immigration of the Dorians; of the Romans, since the foundation of their empire; of the period of the Primitive Christians, of the Sassanides, of the Hindoos, of the Mohammedans, and those groups of Christian architecture relating thereto. By this work the author intends to give an historical review of the artistic architectural productions of all nations from the remotest times. The manner in which each tribe of the human family participated in that great monumental activity, according to its own peculiarity, is fully demonstrated, as well as the peculiar aims pursued and attained by each tribe. Thus the work may also be ranged among those treating of the general history of civilisation. However, considering it in mere relation to architecture, we find its object to be to demonstrate the origin and development of architectural forms, their transpositions and modifications, and to point out the essence of those forms created, as it were, spontaneously and chronologically in the course of time. For this purpose, ample recourse has been had by the author to both written historical traditions and to the remnants themselves of architectural monuments. The arrangement of the work itself is most praiseworthy. It is divided into sections and chapters, according to national and historical groups; each group is treated as a complete whole, from its beginning to its end, the order in which these groups appear being dependent upon the time of their primary development. Each section begins with a general review of the total character of the group, as explained and proved afterwards by historical and monumental tests. Faithful quotations of recognised authorities, contained in marginal notes, give to the work that peculiar stamp of German learning which in the French language is called *citer ses auteurs*.

The last-named work offers a rich material for the study of architecture, sculpture, and painting. The said atlas is divided into three parts, the first representing the monuments of ancient art, the second those of the romantic art, and the third the monuments of modern art; forming altogether 106 splendid plates, accompanied by an explanatory text.

ST. JOHN'S CATHEDRAL, SALFORD.

Messrs. WEIGHTMAN, HADFIELD, and GOLDIE, *Architects.*

(*With an Engraving, Plate* XIX.)

WE present our readers with an engraving of the stalls in the choir of Salford Cathedral. They are twelve in number, with a bench for the choir boys in front, all carved in oak, and elaborately panelled and sculptured on the sides and elbows in various foliage, with very spirited and characteristic emblems of the Evangelists at the ends of the stalls at either side.

Besides the woodwork on stalls, the roof of the choir, and choir aisles, have been entirely groined in wood, examples of which manner of construction are found in various ancient churches—Selby, for instance, whence this portion of the fabric was originally copied. The bosses at the intersection of the ribs are carved into various representations according to the situations. Thus, over the high altar they represent our Lord throned, with the Evangelists about him; over the ladye-chapel angels bearing lilies, elsewhere St. John writing his gospel, &c. The smaller bosses are composed of rich foliage. These roofs have been richly coloured, and decorated with elaborate running patterns along the ribs, and the groins filled with stars on an azure field. The vaulting shafts, and the niches which terminate them, have been likewise enriched with colour, as well as the six statues they contain, of the four doctors of the church (SS. Gregory, Ambrose, Augustine, and Jerome), and SS. George and Edward. These six statues have been very richly adorned, after the manner of the statues in Cologne Cathedral, and though in themselves anything but works of art, having been executed by other hands some years ago, and now doubly heavy and devoid of expression when compared with the exquisite statuary in the new reredos, &c., still have the effect of distributing the colouring of the windows and roofs. The roof painting has been executed by Mr. H. T. Bulmer, of Sheffield. The colouring of the roofs and windows is carried out by a judicious arrangement of Minton and Co.'s mosaic tiles.

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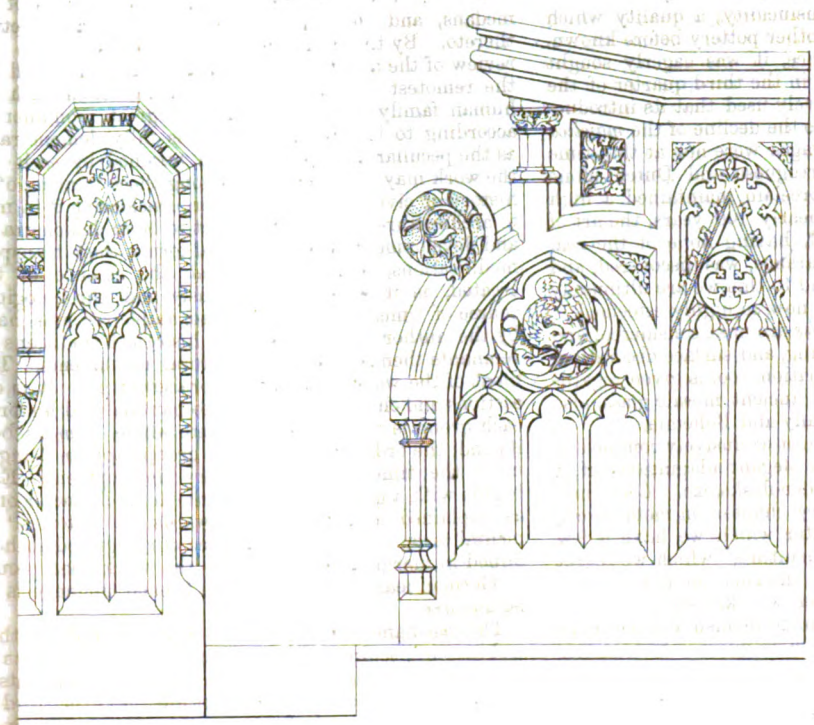

END ELEVATIONS.

BOYS BENCH.

CANONS STALLS.

St. Johns Cathedral, Salford.

Choir Stalls.

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OPEN FIRE-PLACES, AND THEIR CONSTRUCTION.

By S. E. Rosser, C.E.

[*Paper read at the Royal Institute of British Architects, April 14th.*]

In a climate such as ours, subject to greater vicissitudes of temperature than occur in most other countries, the open fire-place is not the least important of the means by which these disadvantages are partially overcome. It is a subject of frequent remark that people complain of cold in an apartment maintained at a temperature of 60° by the introduction of warmed air, while no fault is found if the room has an open fire, although the temperature may be 4° or 5° lower.

The principal objections to the open fire-place as ordinarily constructed, are the large expenditure of fuel in proportion to the effect produced, and the difficulty of warming an apartment equally and effectually. According to Dr. Franklin, not more than a fiftieth part of the heat generated was rendered available for warming apartments when he resided in England (1725); somewhat later (1798), the loss was estimated by Count Rumford at fourteen-fifteenths, and recently by Dr. Arnott at seven-eighths of the whole quantity consumed.

The heat which escapes in the smoke is computed at more than one-half; the loss by the warmed air of the room constantly entering the chimney above the fire is said to be two-eighths, and one-eighth of the fuel is supposed to pass away unburnt in the smoke.

In reference to the unequal heating at different distances from the fire, it is observed that the effect of radiant heat is inversely as the squares of the distances; so that the walls of an apartment are scarcely heated, and therefore reflect no heat on persons in the room, who, if they sit at a distance from the fire, are too cold, and if near it, are too warm. More serious causes of objection are the cold draughts created by the air rushing in through the crevices of the doors and windows, and playing upon the backs of persons sitting round the fire; or forming a cold bath several inches in depth on the floor, in which their feet are constantly immersed. Another objection, but hardly a just one, is bad ventilation. That the usual mode of ventilating a room by the air escaping from it up the chimney is not the most perfect, may be admitted, but it is at least a tolerably efficient method, and infinitely superior to that afforded by the thermometer stove, or any of the varieties of Russian, German, American, and Swedish stoves; being objectionable rather on account of certain contingent disadvantages than of its inefficiency.

The last objections are the smoke and dust.

All these objections applied, more or less, to most of the open grates in general use when Dr. Arnott's 'Treatise on Warming and Ventilation' was published, or to the flues or fire-places provided for them, and they have been received by many as conclusive against the open fire-place being worthy of adoption as a mode of warming in a scientific age.

It is the object of this paper to show by what improvements the open fire-place has been, or may be, rendered less obnoxious to these objections, and of more enlarged utility.

Among the first who directed attention to the improvements of the domestic hearth, Count Rumford is the best known in this country. The alteration which he made was very simple, but its success had the effect of remodelling all the arrangements of the fire-place, and it has been the parent of the numerous register stoves now seen, which have swept away the goodly chimney corners and wide open fire-places of our ancestors.

This change was effected by contracting the throat of the flue. Within the large cavity of the chimney-opening he formed, as it were, a second fire-place by building a wall in front of the chimney back, and so much in advance of it, that when carried up to the level of the arch at the back of the mantel, a space of not more than 4 inches was left for the depth of the throat, from the back of the arch to the face of the new wall. He then contracted the opening over the fire by placing upright covings of brick in each interior angle of the recess. These formed an angle of about 135° with the back of the fire; the distance between the re-entering angles of the covings being in no case greater than the width of the perpendicular part of the flue. By this arrangement the area of the throat of the chimney was reduced to 72 inches, and in many cases made even a third less. To facilitate the sweeping of the flue, the upper part of the back wall was formed with a slab of stone, or fire tiles, which could be pushed back to allow a boy to pass into the flue, and replaced.

The immediate results of these alterations were the entire prevention of smoky chimneys, increased heat thrown into the apartment, and a degree of general comfort previously unattainable.

Soon after Count Rumford's fire-places had become known, register stoves having somewhat the same appearance were introduced. Their elegant design, in iron and polished steel, and Rumfordised form, did not obviate the bad effect of substituting metal for non-conducting material, fire-brick.

In these stoves the metal back of the grate would soon be destroyed if the heat were not rapidly carried off by the air on the other side, in the cavity purposely left behind the stove which communicates with the chimney. The very circumstance, however, of the iron back being preserved by constantly parting with the heat received from the fire to the air behind it, prevents the fuel in its vicinity acquiring the temperature necessary for perfect combustion. In a grate with iron sides and back, the fuel in contact with the iron is always seen black on the edges, and the fire cannot be made to burn vividly, or without forming smoke. But when the grate is lined with fire-brick (which is a bad conductor), of considerable thickness, the brick retains the heat imparted to it by the incandescent fuel, upon which it re-acts, until the fuel and fire-brick are heated up to a clear bright fire, free from smoke, and presenting a mass of radiant incandescence, having three times the power of a grate holding the same quantity of fuel but lined with iron. Very little heat can be obtained by radiation from a small fire in an iron grate, but a very small grate lined with fire-brick will give out a large quantity of heat, and less of the fuel escapes up the chimney.

A very cheap, efficient, and handsome fireplace may be formed on the model of Count Rumford's, by filling the chimney opening with what is known in the trade as a "sham," *i.e.*, the front of a common register stove without any of the ironwork that forms the body. The place for the fire is formed by building up the sides and back with fire-brick, and giving to each coving an angle of about 135° with the back. The bottom grate is from 5 to 7 inches deep from front to back, according as the front bars are straight or curved; and the brickwork at the back slopes upwards for about 12 inches from the bottom grate, and is thence carried up with the covings as high as the centre of the arch over the chimney opening. At this level the throat of the flue is contracted by fire-tiles, stone, or an iron plate, to a breadth from front to back of about 4 inches.

The sweeping machine generally renders the moveable slab unnecessary. If, however, free access to the flue above the throat is required, the contraction can be made with an iron plate, hinged to the back of the front, like the top flap of a common register stove.

Count Rumford made the flue opening into the chimney as nearly as possible perpendicular over the burning fuel. The discovery that this is not an essential condition has of late years led to the introduction of an entirely new class of stoves, in which the fire-place is closed completely over at top, and the smoke passes into the chimney through a luffered opening at the back.

Both the last-mentioned stoves throw out an amount of heat, which few register stoves with fire-places of the same size are capable of emitting.

That the position of the fire near the hearth is of the utmost consequence to the efficiency of any grate, is now universally acknowledged. This position lessens the direct radiation upon the faces of persons sitting near the fire, and throws more upon the legs and lower part of the body. The property of warmed air to ascend renders it necessary, for the general warming of a room, that the fire should be as low as possible, because heat, though readily carried upwards, cannot be communicated downwards. Hence the difficulty with the old-fashioned grates, mounted up 15 or 18 inches from the floor, of heating the air of the room below the seats of the chairs.

But an attempt has lately been made to revive the fashion of putting the fire half-way up the chimney, and it has been argued that when it is considerably above the floor it will be in a better position to radiate downwards than when nearly on a level with it. This argument, however, is based upon an imperfect appreciation of facts. If the fire were a globular body, equally incandescent over its whole surface, the amount of heat radiated from its underside would be as great as that thrown upwards or forwards. No fire-place, however, that has yet been constructed is equally incandescent on all sides,

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The Staffordshire fire-place, as it has been termed, is the nearest approach to the globular form, and it throws out more heat from its under surface than any other fire-place. The bottom of an ordinary grate is a mass of iron-work, which intercepts any amount of radiation, and this iron-work does not even become tolerably warm, because it is kept cool by the current of cold air rushing over it to feed the fire. Moreover, the space between the bottom bar and that immediately above it is commonly filled with dead ashes and dust, which materially impair the efficiency of this part of the fire, even to radiate heat in horizontal lines. The more we consider these facts, the more we shall be convinced that it is only the upper surface of the fire, and that portion of the front which is comprised between the two upper spaces of the bars, that are of any value in regard to radiating power.

The restoration of the fire to its old position on the hearth led to the innovation of placing the aperture for the escape of the smoke at the back of the grate instead of over the fire. In Sylvester's grate, the opening into the chimney is at the back, and it is provided with a series of louvres, which can be opened or closed at pleasure. The draught is always strongest through the lowest of these openings, two of them (giving in ordinary cases an area of about from 20 to 30 inches) being generally sufficient to carry off the whole of the gaseous products of combustion. The upper louvres may be opened to give increased ventilation where no other outlet is provided. As less air escapes up the chimney in this grate, the indraught of cold air is proportionately less, and as the low position and the extensive radiating surface allow the calorific rays to penetrate to the lowest level of the apartment, the entering air derives a larger portion of heat from the floor in its passage to the fire. Experience has proved that this stove is capable of producing about double the effect of an ordinary register, with an equal quantity of coals. Estimating the amount of heat radiated at fifty per cent. of the calorific power of the fuel, and measuring the superfices of uninterrupted radiating surface from the burning fuel and from the sides and back of the grate, we conclude that the amount of heat radiated from this grate is not less than three-eighths of all that is evolved in the process of combustion. Since the invention of Sylvester's, several stoves have been introduced, which possess considerable merit, and mark a tendency to adapt a principle of construction essentially different from the great improvements of Count Rumford. Stevens', Wright's, and Jobson's, are excellent specimens of this class.

A kind of stove lately revived and commended by Dr. Arnott, for its smoke-burning qualities, is an exception to the present general practice in regard to the height of the fire above the floor. This grate might, however, be rendered even more efficient in its heating powers, and its unsightly appearance obviated, if the coal box, which occupies the lower part and really causes the high position of the fire, were made to descend into the back hearth, where depth for the purpose may generally be obtained.

Previously to Count Rumford's improvements, various plans were suggested for modifying the construction of fire-places. The principal seem to have been directed to increasing the amount of radiation from the burning fuel. Sir John Winter's (1658), and Prince Rupert's (1678), are good examples. Perhaps the most scientific series of experiments was conducted by Cardinal Polignac, who, in addition to contrivances for increasing the amount of direct radiation, made use of reflectors to throw the heat into the apartment. His useful treatise, 'La Mechanique du Feu,' Amsterdam, 1714, contains the following passage: "It seems that those who have hitherto built, or caused chimneys to be built, have only taken care to contrive in the chambers certain places where wood may be burnt, without making a due reflection that the wood in burning ought to warm those chambers, and the persons who are in them." The first part of the treatise is devoted to the fire and the interior disposition of the front part of the fire-place for the purpose of augmenting the heat. It states that there are three ways in which the heat of the burning fuel is made effective for warming a room: by direct radiation, by reflection, and by conduction and transmission. Examples of fire-places are given, in which the quantity of radiated heat is increased by parabolic reflectors of iron or brass placed in the jambs of the fire-place. The second division treats of the interior disposition of the back part of the fire-place, and of using the conducting property of iron to transmit a portion of the otherwise lost heat of the fire and smoke to atmospheric air, the properties of which are considered well calculated for conveying heat from the surfaces of the metallic substances round the fire to distant parts of the room. Several fire-places are described, in which the back, jambs, and hearth, are made with hollow spaces, or caliducts, for the purpose of warming a copious supply of external air, afterwards admitted into the room by an opening controlled by a valve or regulator. The variety of modes in which this plan may be applied renders it extremely valuable. Adjoining rooms may be heated from one fire-place in the partition wall; for by making a fire in one room the heated air from the caliducts may be discharged into the other, or the warmed air may be conveyed to any of the upper rooms.

The Polignac fire-places were constructed for the consumption of wood fuel, but Dr. Desaguliers modified them so as to admit of coal being burnt. His fire-places were much appreciated for a time, but subsequently fell into disuse, from the supposition that they burnt the air. It is possible that the more intense combustion of a coal fire in a grate might give to the iron plates that formed the sides of the caliducts a higher temperature than they had in the Polignac fire-places, but with the large proportions which he gave to his air-channels this result might be avoided.

Many contrivances, similar in principle to Savot's (1626) and Polignac's grates, have been brought forward, and Dr. Franklin (1745) invented a stove known as the Pennsylvania stove, which combined, to some extent, the peculiarities of Polignac's arrangement with the descending flue in Prince Rupert's stove. The proportions of the caliducts, however, in Franklin's stove make it rather questionable whether it did not overheat the air. It is said of one of these stoves, which was adapted to burning coal, that it kept a room 14 feet square at a temperature of from 60° to 64° for thirteen hours, with a consumption of one peck of coals, the external temperature being 28°.

M. Peclet's work, 'Traité de la Chaleur,' chapter 13, contains descriptions of several fire-places for utilising a portion of the heat which passes off with the smoke, by applying it to warm a supply of fresh air for the apartment.

It is possible to modify these arrangements in very many ways, but the conditions to be observed are, to dispose the heated surfaces so that they may be efficacious, to give a sufficient area to the air ducts, and lastly, to render the tubes and the joints sufficiently tight, that the smoke may not mix with the warm air.

These treatises show the attention which the subject of the economy of fuel has received in other countries. It is probable, however, that in our own country there are few architects or scientific men, who have not themselves tried or seen the results of experiments conducted with the same object. It has occurred to some to increase the amount of effect derived from the combustion of fuel in ordinary fire-places, by admitting the external air to an enclosed chamber at the back of the fire-place, where it becomes warmed by contact with the cheeks of the grate, and is then admitted into the apartment, through perforations in front of the grate. Where a spare flue exists in the chimney breast, the warm air may be conveyed through it, and discharged through an opening near the ceiling of the same apartment, or conveyed to an adjoining room, or to one on an upper floor.

An instance of the benefit derived from these or similar contrivances, though on a small scale, is worth mentioning. A building of only one story in height, in a very exposed situation, the flue from the fire-place having very little elevation, was constantly subject to smoke. The door opened directly into the open air, and on the same side there was a large window. When the fire was lighted, if the chimney drew at all, there were such currents of cold air from the crevices of the door and window, that the largest possible fire could not warm the room. The following remedy was applied:—An opening 14 by 9 inches, was made in the external wall opposite to the fire-place, a little beneath the level of the floor joists. This communicated with the space under the floor boards. Beneath one of the jambs of the fire-place, a channel was formed communicating with a chamber on one side of the grate. The stove consisted of a fire grate and front bars, set in brickwork with splayed covings, leaving a triangular chamber in each corner, the one on the left being connected with the channel already described. Two pieces of square cast-iron pipe, each 4½ by 3 inches, were fixed horizontally at the back of the fire, a fire-tile 2¼ inches thick forming the back of the grate between them and the fuel. The ends of both pipes were open to the triangular chambers. From the top of the right-hand chamber, a flue, 9 by 9 inches, in the chimney breast by the side of the smoke flue, opened into the room between the

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mantel-shelf and the ceiling. The cold air entering through the aperture in the external wall passed under the floor into the cold air chamber on the left of the fire-place, then through the iron tubes (by which it became warmed) into the warm air chamber on the right, and up the vertical flue into the room. The result was, that during extremely cold weather the temperature was raised to such a degree, that the external door was often left open when snow lay upon the ground; the chimney no longer smoked; instead of currents of cold air into the room, warm air passed out of it; and the ventilation was so good, that several persons smoking for an hour or two did not occasion any smoke to accumulate.

Air flues constructed in the chimney breasts, when a house is built, would materially promote the comfort of the inhabitants. These flues might have openings at bottom communicating with the external air, and if they were carried up alongside the smoke flues from the different fire-places, or connected with the void spaces round the grates, a considerable portion of the waste heat, usually escaping by the chimney, would be communicated to the air in the flues. Apertures should be made into them at their upper part to communicate with the various rooms, and a continuous supply of tempered air might thus be provided to maintain salutary ventilation, to supply the requisite quantity of air to the fires, and to afford an increased degree of warmth.

Chimney openings have not generally sufficient depth to receive grates of the most efficient kind. The practice of making the breasts project into the room, and the necessity for restricting the projection to the smallest limit, have led to the modern custom of making the recess of the chimney opening only a brick and a half in depth. If all the flues were built in the party-wall, no chimney breast would be required above a projection of a brick, or half a brick at the fire-place itself, which might be concealed by, or form part of, the chimney-piece.

Where fire-places are situated in an external wall, the difficulty of providing a supply of air is not felt, as a hole may generally be made directly through the wall at the back; but as in town-houses they are generally formed in the party-walls, independent flues must be brought up for the purpose by the side of the chimney breasts, and openings cut through the jambs.

Where there are several stories, it would be difficult to supply air to the upper rooms, as the smoke flues from the lower rooms would generally interfere between the air-flues and the fire-place. In some cases an air flue might be formed in the floor by using the space between two joists in connection with a grating in the outer wall, and carrying an iron pipe, 3 or 4 inches in diameter, under the hearth through the trimmer and trimmer-arch into the space behind the fire-place. This arrangement, however, requires the trimmer joists to be strengthened, and in London, the Building Act might probably prevent it, while the supply of air so obtained would be less than is desirable. It is, however, possible in most cases to make some arrangements for the supply of air; but it would be preferable that adequate provision should be made in all new houses, either by air flues in the party-walls, or by other modes which will suggest themselves to the architect.

Referring to Cardinal Polignac's statement as to the three modes in which the heat of burning fuel may be rendered serviceable for warming, viz., by radiation, by reflection, and by conduction; we have seen how they may be combined to produce an effect very different from that of the stoves to which Dr. Arnott's remarks applied.

By the use of fire-brick linings, and by placing the aperture for the escape of the smoke at the back of the fire, we increase the intensity of the combustion, and the consequent radiation.

By the use of reflecting surfaces, we ensure nearly all the radiated heat being directed into the room.

By placing the fire upon the hearth, and by properly arranging the conducting materials, we greatly increase the amount of radiation, and destroy the cold foot-bath which accompanies a fire raised much above the floor; while, by introducing warm air chambers and caliducts, we abstract a large portion of heat from the smoke, and employ it to warm a supply of fresh air for the room, which prevents cold chink winds, one of the principal objections against the open fire-place, and corrects the tendency to unequal heating which arises when we depend on radiated heat alone.

By diminishing the quantity of air escaping up the chimney, we reduce its liability to smoking.

By the use of sunk ash-pits or concealed ash-pans, in conjunction with low fires, we prevent the dust being diffused into the room.

As regards bad ventilation, it is by no means evident that this asserted objection to the open fire-place is correct, but granting that the fire-place ought not to be the only means, modern practice has given us numerous contrivances by which efficient ventilation may be obtained, while on the other hand it is certain that so long as we allow the fire to draw its supply of air from the room, we must have some ventilation. As much disappointment is often occasioned by the want of knowledge as to the points which constitute a good stove, the following remarks are offered in the hope that they may be found useful.

1. The fire should be as near the floor as possible.
2. The opening of the front should be low.
3. The grate should be lined with fire-brick.
4. A shallow fire with a large upper surface is better than much front with a contracted upper surface.
5. A stove from which the smoke escapes from the back is better than one from which it rises directly into the chimney.
6. A contrivance for regulating the quantity of air escaping up the chimney is very desirable.
7. The use of a blower in any form is only waste of fuel.

Guided by these rules, a purchaser would choose Sylvester's, Stephens', Wright's, or Jobson's stoves before all others; while a combination of the reflecting surfaces of the body of Stephens' with the radiating hearth of Sylvester's makes the most efficient and economical stove that has yet been manufactured. Caliducts for heating the air may be applied to all these stoves at a small cost.

The stoves recommended are adapted for the principal apartments, but, as they are expensive, the bedchambers and inferior rooms may be provided with good register stoves.

In a register stove the fire should be fixed as low as possible, the top bar being not more than 11 inches from the hearth, and the opening in front not more than 30 inches wide, and of about the same height in an ordinary apartment.

The cheeks should be set at an angle of about 135° with the back, and polished to make them better reflectors. The fire should not be more than 6 inches high, and 8½ inches or 9 inches deep from front to back; the back and sides being lined with fire-brick. Its projection should be confined within the line of the front when the products of combustion pass directly upwards; but when they escape through luffers, or a door at the back, the fire may be brought more forward, the limit being the danger of a cross draught if the projection exceeds 3 or 4 inches.

For plainer fireplaces, nothing better can be used than the sham register front with fire-brick cheeks, on Count Rumford's plan.

The following rules for setting stoves may be found of service.

1st. To let no air enter the flue, except what passes through the opening provided for the escape of the smoke. If it be desired to have a ventilating opening into the flue from the upper part of the room, the propriety of forming it will depend upon the draught which ordinarily exists in the flue. It will generally be better to use an unoccupied flue for the purpose of ventilation.

2nd. The grate should be kept as much forward into the room as is consistent with appearance. It is a mistake to suppose that it is more likely to smoke when brought well forward than when pushed back into a recess, provided cross draughts are avoided.

3rd. The flue in common register stoves should be brought down of equal dimensions perpendicularly over the fire, the register contracting the opening at the bottom, or, where the escape of smoke is at the back, the flue should be brought down at the back of the grate, and be made perfectly air tight.

The gathering wings usually constructed over the openings of fireplaces are perfectly useless.

In conclusion it may be remarked, that with the improvements introduced into modern grates, the heat afforded for the warming of a room ought materially to exceed the proportion stated by Dr. Arnott, whose observations seem to have been made upon stoves of an imperfect construction.

Discussion.—In answer to an inquiry, Mr. Rosser said that the Staffordshire grate was commonly used in road-side inns and farm-houses in the Midland Counties, without the accompaniment of a fender. The first impression of such a grate would be that the chimney *must* smoke,

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the whole of the fire being beyond and in advance of the flue, whereas he had never seen one which did smoke. The same thing might be seen in Sylvester's grate; and he presumed that the body of air in the room, pressing towards the aperture, deprived the smoke of its tendency to escape into the room, and thus forced it up the flue. The success of this kind of grate was the more remarkable, as the fire was exposed to all kinds of cross draughts. If the grate receded instead of advancing, there would be far less radiation.

Mr. BAKER remarked that the Staffordshire grate was alluded to under the name of the Pot-house by Vernon, who suggested that a hood should be placed over the front of it, in order to reflect the heat into the room. But it was considered that a hood would prevent the pressure of the air adverted to by Mr. Rosser.

Mr. T. H. WYATT referred to a grate in the office of Mr. Burn, which was subject to a cold down draught, the supply of air for the fire being taken from outside the house.

DR. ARNOTT observed that the subject was a very extensive and interesting one. The theory and principles of combustion were frequently quite opposite to the facts which occurred in the action of chimneys. He had no doubt that with some further study of the subject, some of Mr. Rosser's opinions would become changed. With regard to low fires, it would be found by placing a thermometer on the floor, that a fire on the hearth did not dart a single ray of heat upon the carpet. The whole of the heat of a low fire would be found to ascend, and the feet of the people sitting in front of it became cold. Many of the opinions advanced on the subject of fireplaces were no more true than the old opinions, that the sun rose and set instead of the earth turning round. M. Peclet, whom he had seen in Paris, had told him that the normal condition of all the chimneys in Paris was to smoke. The dearness of fuel caused the people there to keep their fires half smothered, and to shut the inside of the chimneys and let the smoke into the room. The smoke, indeed, was made so cold by the channels round the fire that the necessary intensity of ignition was prevented; so that less heat was obtained from the fire, and the smoke was so cold that the external atmosphere was not sufficient to make the chimney act. The tops of all the chimneys in Paris exhibited in a striking manner the distress of the inhabitants, by the great variety of cowls which ornamented them.

In answer to an inquiry, whether he went so far as to say that the higher the fire was raised above the floor, the warmer the room would be? Dr. Arnott said, within certain limits. He described the effect produced by substituting, in his own drawing-room, a low fireplace (the very best which a good ironmonger could supply) for one that was raised above the floor. He found with the low fire the cold affected his feet most severely. He considered a grate should be raised about 14 inches from the floor.

Mr. SMITH observed that there was scarcely any subject which had been so much discussed, or upon which so many conflicting opinions were entertained, as on the question of warming domestic apartments. Even in the operation of stirring a fire, almost everybody considered his own plan the best. He referred to a grate in which the fire was made upon a polished iron hearth without any grating or aperture beneath to feed it, and the result was perfectly satisfactory; the fire drawing remarkably well, and giving out a very considerable heat. The same plan, however, had been tried, on his description of it, at another place where it had not answered at all. The cowl, as an appendage to the chimney shaft, was not peculiar to Paris. It was as common as possible in London, and even the chimneys of Buckingham Palace were not exempt from it. The horizontal shelf behind the Staffordshire grate he considered a very good contrivance. Most of the inns and many private houses in Yorkshire had a similar arrangement, the shelf holding a sufficient quantity of coals to last all day. Reasoning upon this arrangement, he had been induced in his own house to adopt the plan of warming the coals beneath the grate before placing them upon the fire, and he found the combustion more perfect, and the smoke much less in consequence. His fireplace was upon a plan of his own,—the front of the bars being in a line with the front of the chimney-piece, and therefore in advance of the walls of the room. This grate drew exceedingly well, but was liable to disturbance from cross draughts.

Dr. ARNOTT assented to the importance of warming the fuel before placing it on the fire.

Mr. T. H. WYATT referred to a case in which smoky chimneys had been caused to a great extent by the defective pointing of the brickwork of a large stack of chimneys. He had rebuilt these chimneys, forming the part above the roof with hollow bricks, which he found had a very good effect.

Mr. NASH stated that in his own practice he had introduced cold air at the hearth, and found it to cure a smoky chimney. It might be thought that the introduction in this way of air that had not been previously warmed would be inconvenient, but he had not found it so. Even if the quantity of air so introduced was very great indeed, he found, on opening a window at the top, that the air instead of coming in was going out; the fire rarefying the air so much that it overbalanced the indraught at the window. He had adopted this plan with complete success in a room, the chimney of which had previously smoked. He introduced the air exactly in front of the fire by two perforated copper boxes, or in other cases by a grating with a large air chamber under the hearth; though the latter plan was rather objectionable, inasmuch as it became in some degree an ash-pit.

Mr. T. L. DONALDSON sketched and described a grate in his own dining-room, constructed by Mr. Cundy. It had a back of fire-brick inclined forwards. The air was brought from outside the room through a channel and escaped immediately under the grate. The heat given out was considerable, and the room, though spacious, was perfectly warmed.

Mr. BAKER mentioned a case in which he had adopted one of the Farnley Company's fire-brick fireplaces in the shape of a niche. The hearth, which was of fire-brick, was raised 3 inches above the floor; cold air was admitted underneath. The fireplace was made upon Leslie's principle, without any false front. The fire-brick consumed the smoke that was generated; but he found it was necessary to keep the hood thrown back, in order that the smoke might pass up the chimney. This stove, which was 22 inches wide, warmed perfectly a room of 40 feet by 24 feet. The fire-brick itself was not however a satisfactory specimen.

Mr. NASH confirmed Mr. Baker's statement as to the heat given out by the Farnley stoves, which he had seen used in Yorkshire. The fire-brick getting hot, the heat was powerfully radiated into the room from the dome.

ON FIRES AND FIREPROOF STRUCTURES.

WE last month inserted in the *Journal* (*ante* p. 127) a Paper on the above subject, by Mr. James Braidwood, Superintendent of the London Fire Brigade, read before the Society of Arts, May 7th. A very lengthened and interesting discussion subsequently took place, and several communications relative thereto were laid before the meeting; our space, however, will not permit us to give more than the principal remarks and arguments brought forward.

Mr. SIBLEY, in a note to the Secretary, says, "I beg to adduce one fertile source of fires, that is, the fixing of the boiler furnaces of steam-engines, and other furnaces and close-fires, against party-walls, in which wood plates and bond timber are not unfrequently found. Under the Act of 1844, a clear space of 6 inches was made imperative, between the setting of the furnace and the party-wall. Under the present Act they are subject to *no* restriction or regulation whatever. The only difficulty to be overcome is, the wedded habit of building to this mode, and the trouble that anything apparently new involves. The disuse of bond timber and plates altogether; the introduction of iron hoop bond, and stone templates in their place; the building of cross walls, in lieu of hollow wood partitions, would tend much to diminish the hazard of fire. Wrought-iron brestsummer girders should also take the place of wood brestsummers; when these are burnt through, it is manifest that the whole superincumbent mass of brickwork has nothing for its support."

Mr. CHADWICK, C.B., said that the Society would, no doubt appreciate highly the precautionary admonitions, as well as the suggestions of structural arrangements for the prevention of calamities, communicated from a gentleman to whom was due the example of a centralised and well managed establishment, which contrasted with the numerous separate establishments of the parochial, or so called local self-governments. He (Mr. Chadwick) had occasion to examine the administrative arrangements for the repression of fires in the metropolis, as well as in other places. He had found that there were in the metropolis 150 separate parochial fire-engines and stations, and only 17 engines or land-stations of the Fire Brigade; yet, notwithstanding that the relative proximity of the separate locally-managed engines, as compared with those of the central establishment, might be stated to be as the relative numbers, or as 9 to 1, yet in two fires out of every three, the engines of the centralised and systematised establishment were first on the spot, and the relative efficiency of their action when on the spot need not be described. But, quick as they were, or could be, he yet found them to be deplorably too slow. Mr. Braidwood had admitted in his testimony that in the great majority of instances, that is when the fire had got hold of the premises, it was a waste of power to attempt to save the premises where the fire broke out, and that its best application was in preventing its extension to the premises contiguous. He (Mr. Chadwick) had got the police to note the time which elapsed between the first alarm of fires and the arrival of the engines; and the return upon the first group of observations was 36 minutes. It appeared that the engines traversed the streets, allowing for obstacles, at a rate of 10 miles an hour. Information would be conveyed to the stations of the brigade at a rate of five miles an hour. In the case of the occurrence of a fire within a mile of the station, the information would be conveyed in 12 minutes; the horses would be put to and the engine got out in about 5 minutes on the average; it traversed the distance and arrived at the fire in about 6 minutes more; the water had to be got and got into the engine, which would occupy about 5 minutes; making about 28 minutes; or, for a half mile distance, an average of not less than 20 minutes, which must occur under the most favourable circumstances. This arrangement he could not but consider as fatally too slow. A pail-full of water might suffice

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within the first minute, after ignition; in the second minute more than a ton weight would be required. In respect to fire-escapes, Mr. Braidwood himself had testified that they would seldom be of use unless they were on the spot within 5 minutes after the alarm was given. On an impartial consideration of the facts, he was confident that practical concurrence would eventually be given to the conclusion at which he had arrived, that the principle of all future arrangements for the repression of fires must be a constant supply of water kept at high pressure night as well as day, and the direct application of it from the mains before the door by means of a hose and jet. By that arrangement he had proved, that a power equivalent to three or four of the best engines might be kept constantly before each door ready for application within two minutes. Having been consulted on the subject by Mr. Edward Rushton, the late benevolent stipendiary magistrate of Liverpool, and having learned of the corroborative example of the use of water direct from the mains, first for the cleansing of the streets and houses at Philadelphia, and then for the extinction of fires, he (Mr. Chadwick) gained his advocacy of the plan at Liverpool. When, upon his advice, Mr. Rushton proposed it to a committee of the House of Commons, the proposal was received with laughter. The very serious effect of the conflagrations in the warehousing interests at last occasioned it to prevail in Liverpool, and, as had been stated in the paper, with such an effect in increased safety, as was shown in the insurance charges. In a communication to him, Mr. Newlands, the borough surveyor of Liverpool, had stated the new practice: "The mains from this reservoir under high pressure, are available over the whole of the town.....On arriving at a fire the stand pipe or pipes are put down, and the hose run off the reels in an instant, and, it may be, a dozen jets are playing, and the flames nearly extinguished before the engines have left the yard.....Serious fires are now seldom heard of, for before the flames can gain head the jets can generally be played upon them, and this is the only time that there is a chance of subduing them." The mechanical or engineering objections made to the application of the like arrangements to the metropolis were wholly illusory. On a competent and impartial examination it would be found, that what had been done in some cities might be done with economy in the metropolis and all others. Mr. Baddeley, who had attended all the principal fires which had occurred in the metropolis during the last thirty years, and who had given anxious attention to the subject of the water supply, had testified that by arrangements which should ensure the application of water to fires within even 5 minutes after their commencement, the progress of two-thirds of them would be effectually arrested. Mr. William Lindley, the engineer who had rebuilt that portion of the city of Hamburgh which had been burned down, and who had stated that, in that rebuilding, he had been guided in his arrangements for house and main drainage and water supply by the principles laid down in his (Mr. Chadwick's) sanitary report, had given in respect to the arrangements of the water-supply, the following testimony which was complete and conclusive in itself:—Mr. Lindley was asked—

"Is the jet used at Hamburgh for watering the streets? Yes; and the charge has been 1d. per foot of frontage per annum.

"What provision is made with the new system of works which you have laid down for the prevention of fires? The mains are large—from 6 to 20 inches diameter—constantly charged at high pressure; being supplied from the one extremity by two Cornish engines, and at the other level from a high summit reservoir kept constantly filled. Throughout the whole length of the pipeage are placed, at intervals of 40 yards, fire-plugs, of 3 inches diameter in the clear.

"How soon can a jet be supplied for the extinction of fires? In two minutes. The men who get paid by old custom for the use of their engines will come, though they are not wanted, but the power of eight engines may be anywhere applied as quickly as the hose can be screwed on, and introduced *inside* the house where the fire is.

"Have there been fires in buildings in Hamburgh in the portion of the town rebuilt? Yes; repeatedly. They have all, however, been put out at once. If they had had to wait the usual time for engines and water, say twenty minutes or half an hour, these might all have led to extensive conflagrations.

"What has been the effect on insurance? The effect of the rapid extinction of fires has brought to light to the citizens of Hamburgh, the fact that the greater proportion of their fires are the work of incendiaries, for the sake of insurance money. A person is absent; smoke is seen to exude; the alarm of fire is given, and the door is forced open, the jet applied, and the fire extinguished immediately. Case after case has occurred where, upon the fire being extinguished, the arrangements of incendiaries for the spread of the fire are found and made manifest. Several of this class of incendiaries, for the insurance money, are now in prison. The saving of money alone, by the prevention of fires, would be worth the whole expense of the like arrangements in London, where it is well known that similar practices prevail extensively."

Mr. JOHN BRAITHWAITE could not say to whom the greater compliment was due—whether to the Council of the Society, in having requested Mr. Braidwood to indulge the Society with the valuable paper that had been read; or whether to Mr. Braidwood himself, for the able manner in which he had put together so many ideas. It was the most valuable subject, perhaps, with the exception of one, that had ever been broached in the Society. In the early period of the building of Drury-lane theatre, every possible means was adopted to prevent fire occurring, under his father's directions, in conjunction with Colonel Congreve and the late Mr. Whitbread. It was carried out to a perfection that was almost unheard-of, or thought to be practicable. There was not a spot in any part of the theatre but that, at one moment's notice, they could control any chamber, however remote or however near, by—not a deluge of water, but sufficient water at a particular moment to arrest the progress of the flames. The greatest advantages experienced, however, were from two small garden-engines, that cost but 15*l.* each, one in each fly; so that the instant there was anything like conflagration, the small branch, with a fan-top to spread the water, was applied, and the fire was extinguished even whilst the performances were going on. Many times had the theatre been on fire under such circumstances, and many times successfully extinguished, with only a few gallons of water. About that period, Mr. Salmon, one of the agents of the Duke of Bedford, introduced the portable or chamber fire-engine. He (Mr. Braithwaite) was, at the time to which he alluded, an extensive manufacturer, and constructed hundreds of these little engines, at the moderate cost of 3*l.* each. Great numbers of people availed themselves of these little portable engines, which held some four gallons of water. They were placed in the hall of their dwellings, and on the bedroom landings; and by them, he believed, many hundreds of houses had been saved from destruction by fire. Mr. Braidwood happily looked upon his fellow-creatures with the same cast-iron nerves that he possessed himself, when he told them to close the doors—to go for water—to creep cautiously into the apartment on fire—and apply the water to the particular portion on fire. Mr. Braidwood could do all that—he had seen him do it—but how many among those present would like to try the experiment. The little water was everything, if they could lay their hands upon it, even in a pint-pot. In the great fire which occurred at Barclay's brewery, all except the malt-lofts was burned down; and he believed that he (Mr. Braithwate) was instrumental in saving some 60,000*l.* worth of malt. The beams had caught fire on one side of the malt-lofts; he went across one of the beams with two pint pots, and carrying a gallon of water under his arm; and by applying it in the way recommended in the paper, he extinguished the fire in the beams, and the malt was saved. He had spoken of the little water; he would now say a word or two with respect to the larger quantity. He must tell them that in 1830, under the special request and encouragement of the insurance offices, he constructed that which would not prevent fires, but would and did extinguish them effectually, and that was the steam fire-engine. He (Mr. Braithwaite) first constructed an engine of 10-horse power, and he was told by the authorities it was too large, and that he would pump the Thames dry. He then constructed one more portable, of 5-horse power, with which he succeeded, without a single failure, at the numerous fires he attended. They were now upon the eve of having a high-service supply of water, so that there would not be a single room in any house in which they could not obtain a continuous supply of water at all times, when by the application of a small cock and a gutta percha pipe within the dwellings, fire engines from the outside might, perhaps, be dispensed with. There was now an Act of Parliament, which he had the honour of assisting to conduct through the House—the Metropolitan Water Act—by which water companies are obliged to supply the best filtered water under pressure from the top to the bottom of houses, at any time and all times. That, he thought, would be one means of averting conflagrations. The numerous fires that occurred were not matter of surprise to him, for which two principal causes might be assigned:—In the first place, the number of houses was doubled, the population was doubled, and the use of gas had multiplied in a ten thousand-fold ratio.

Mr. HAWES said he should like to enquire of Mr. Braidwood how he explained his statement that hot-water pipes, by some chemical action, when placed near wood-work caused fire. Indeed, he was puzzled by the Paper to know which was the safest mode of heating a house. Gas, it was said, was dangerous, so were open fires and close fires, and hot water and steam. He hoped, therefore, we should have something more as to which was the best and safest mode of heating our houses.

Mr. MARRABLE said he was not prepared to go quite as far as Mr. Braidwood in the regulations as to the distances at which it is now the law that all pipes for warming by hot water or steam should be fixed from any wood-work, viz., 3 inches. When high-pressure pipes were used, the precaution was wise and necessary; but he did not think there was any occasion for such a restriction when pipes for hot water at a low pressure only were used. He feared that such a rule might be found very difficult to carry out in all cases. He also dissented from the supposition that "a chemical action took place between heated iron and wood." He believed that the only action was, that the constant heat at last reduced the wood to a state resembling touchwood, which was ready to take fire on the slightest accident. With regard to the difficulty of enforcing the rules respecting the laying hearths free of all timber-work, it should be mentioned that the builders were bound to give notice to the district surveyors, whose business it was to enforce the rules of the Act. This they were not generally backward in doing, although it was possible that some builders might manage to cover up and conceal irregular constructions during the absence of the district surveyor. Moreover, there was always more or less difficulty in getting the magistrates to convict.

Mr. F. WHISHAW remarked, that when this subject was brought before the Institution of Civil Engineers, about four years ago, he stated in the course of the discussion that as bulkheads were useful in preventing fires extending in ships, party walls should be adopted in large warehouses, so as to divide the space and confine the fire to the spot where it originated. That suggestion was approved of by Mr. Braidwood, and also by Professor Hosking, the official referee. He was glad

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to find that Mr. Braidwood still held to that opinion, and it seemed to him that in any future Acts relating to building, clauses to that effect should be introduced. He knew a warehouse in Bermondsey with an unbroken area of wooden flooring of three-quarters of an acre. There were also many large granaries which might be easily divided and fire prevented from extending. Mr. Braidwood seemed to think that the large buildings in the City had been constructed without reference to such precautions. He would mention that a very efficient mode of obtaining notice of a fire breaking out was furnished by the electro-magnetic alarum, which consisted of a simple tube of mercury connected with wires attached to the alarum apparatus and battery, Upon a fire-breaking out the heat caused the expansion of the mercury, by which the circuit was completed, and the electric current was enabled to pass, setting the alarum in action. He confessed he was astonished that the steam fire-engine had not been introduced into London; he was at a loss to conceive why the insurance offices had not adopted that efficient mode of extinguishing conflagrations by which hundreds of tons of water might in a short time be thrown upon the burning mass.

Mr. CHARLES MAYHEW said, as he was surveyor to one of the oldest insurance companies, and a district surveyor, he could speak with some confidence on the subject brought forward by Mr. Braidwood. He begged, in the first instance, to reply to the observations made relative to the steam fire-engines. The reason why they were not generally adopted on land was, that the large quantity of water which they could supply was not, in the generality of cases, required, inasmuch as water injudiciously applied, did very often more damage than the fire would if left to the judicious management of the Fire Brigade to extinguish, which was, in most cases, stopped in a way perfectly astonishing. He had now two damages in hand to make good—one to a large house in Park-lane, where the timbers of the roof caught fire through a defective flue belonging to an adjoining house. The timbers were in a blaze from one end of the roof to the other, yet the fire was extinguished by the Fire Brigade before it got through the greater portion of the slate and lead covering, and although the water had penetrated into the rooms below, yet it was not supplied in such superabundant quantities as to do any serious damage. The other instance was in Strutton Ground, Westminster, where the contents of the shop, which was filled with combustible matter, also the staircase and the two back rooms, were nearly consumed, and the two front rooms over the shop were left entire (the doors being shut), and the furniture was only slightly injured. This showed that a judicious and moderate application of water, by men who thoroughly understood the business, was far better than tons supplied by those who did not understand it. Another reason against the steam fire-engine was, that it must continually have the steam kept up, otherwise it would take too long to bring into use. As regarded the structure of buildings, he was quite persuaded that unless the legislature would adopt strong measures, fires would continue as heretofore. Houses ought to be constructed on the French system, and not as they were built here, on purpose to burn. They were piled up as the wood was placed in a grate to light a fire. The floors were wood, the partitions were wood, the stairs were wood, so put together as to be all hollow, and so connected as to allow air drafts in every direction; and oftentimes the brick walls were what were called battened, allowing air vents behind the plastering. Thus the house was on fire from top to bottom before it was known by the inmates that a fire had broken out, and the doors and windows in the surrounding walls allowed the admission of air to feed the flames. It was difficult perhaps to construct anything fire-proof, but still it could be approximated to; it might perhaps be more costly so to build, but what was cost compared with loss of life? Speculating builders, however, would never adopt this manner of building, unless compelled by an Act of Parliament. With regard to the construction of warehouses, he did not think that anything would be effectual unless they were entirely constructed of brick, which would occupy too much room and be exceedingly inconvenient. Therefore the only way was to confine them to a certain cubical content, as required by the present Act of Parliament. Another source of fires was using common flues for close fires; such flues were only enclosed by 4-inch brickwork, which was wholly inadequate. Another evil was using Welsh fire-lumps at the back of grates, which, if fixed close to the party-wall (especially in old houses, wherein timbers where almost invariably inserted) very often set fire to the adjoining houses. He had recently met with a case of this kind.

Mr. JOHN W. PAPWORTH, F.R.I.B.A., would venture to reverse the order of the remarks made by Mr. Braidwood, so as to inquire, first, whether fire-proof buildings could be made; and found himself, with much pain, opposed in opinion—apparently, but perhaps not in fact—to the authorities named by the author of the Paper just read. He put forward a contrary opinion to Mr. Braidwood's with some hesitation, because that gentleman had had the opportunity of seeing many cases of total destruction; but he was convinced that Mr. Braidwood laboured under the difficulty of condensing the materials for a large book into the limits of a paper like the present. He assumed that it would be agreed that what people called fire-proof materials were literally the least protections in a great fire. Thus, stone staircases were likely to crack at the wall, and fall, long before an equally solid wood staircase would be unsafe to the escaping occupier. Iron beams pulled the whole building down with them, whereas wooden beams, sadly charred, remained long after the engines had ceased working; and, in a great fire, even brick arches failed, and fell. He admitted that very thick arches would stand a great heat; but the little things which were now called brick arches were impotent before even a moderate fire. A friend was saying, last year, that he saw a brick-arched warehouse, belonging to his family at Liverpool, appear to melt down into the flames. Mr. Piper had observed that Yorkshire stone was exceedingly destructible by fire, and that, practically, it did not furnish a fire-proof floor; but this did not appear to be Mr. Tite's opinion. And Mr. C. H. Smith considered that concrete, properly made, would bear a very considerable degree of heat, perhaps more than Yorkshire stone. Mr. Barrett had stated that, supposing any intense degree of heat to be generated, before it would act injuriously on iron and concrete, it would, probably, quite destroy a brick arch, either by disintegration, or by the arch's own expansion. Mr. Braidwood seemed to think that the only fire-proof construction for large warehouses, where an intense degree of heat might be generated, was groined brick-arching on brick piers. He (Mr. Papworth) accepted these discordant statements as evidence to one thing—viz., that none of them were fire-proof in the ordinary sense of the word; and gave great credit to Mr. Braidwood for the distinction drawn between ordinarily fire-proof, extraordinarily fire-proof, and incombustible premises. The public had certainly been misled by the scientific acceptation of common terms. Fire-proof did not mean incombustible, but only "not very likely to be totally destroyed by fire." Covering wood-work with metal was allowed by the insurance offices to be a prevention to a certain extent, that is to say, if a current of air passed between the hearth and the metal that touched the wood. A stone was equally a prevention under such circumstances, but he had seen a case where the hearth touched the stone; both the hearth and the stone had cracked—merely cracked—and the floor below took fire, with no current of air between the plate or stone and the hearth. Such covering was not a certainty of prevention, and, therefore, a second shield interposed was not an extravagant precaution, but was, perhaps, the most real protection that could be given in a case where a stove must be placed upon a floor. Having gone so far, he must own that if faith was to be put in printed documents, in Acts of Parliament, in reports of experiments, in patents, and in sculptured memorials, it would seem that, in opposition to the authorities mentioned by Mr. Braidwood, wood covered with metal was as much fire-proof, as it was more economical than any mode at present put forward as a protection against fire. Mr. Papworth referred to an obelisk erected in 1776, on Putney-heath, by order of the corporation of London, to commemorate the satisfaction felt by committees of that body with experiments made in that year, and described in a pamphlet published in 1785, entitled "An account of the invention and use of fire-plates for the security of buildings and ships against fire." The author, Mr. David Hartley, was M.P. for Hull. A reprint, with additions, by his nephew, in 1834, stated that, "resistance to every possible degree of fire, such as in distiller's shops, or turpentine warehouses, may be accomplished by applying metal plates above and below the timbers, with dry sand or rubbish between them. In experiments repeatedly tried with this double application, the room was filled from the floor to the ceiling with faggots and pitch and tar. As to common dwelling-houses; when the single application of the plates was tried in the experimental house, where also air bricks were provided to the floors, the trials were continued from day to day to the same part of the ceiling and timbers of the house a great number of times after the plaster-work was burnt down and destroyed; but the timbers could never be set fire to, so as to burn of themselves, nor could the fire ever spread sideways; as long as the burning faggots were applied to the timbers, they were charred perhaps to the depth of an inch of their substance, but the plates over them acted as an unconquerable extinguisher, preventing them from taking fire and burning of themselves." Rolled copper plates were specified, as well as those of painted iron. Tinned or galvanised iron or zinc would be equally applicable. In 1774, the sum of 2500*l.* was voted to the inventor by Parliament; and, in 1777, the patent was extended for thirty-one years. If these statements were worth anything, it seemed extraordinary that the system should have died; and it might be desirable that the experiments should be repeated. He (Mr. Papworth) also wished to recall attention to the statements formerly made that timber and woodwork which had undergone Payne's anti-dry-rot process were uninflammable. He regretted that there was not in this country a body that would undertake the verification and comparison of such statements. Mr. Braidwood's hope of preventing fires was by enlisting the active inspection of the masters; but, if his (Mr. Papworth's) view of the case was right, matters would remain just as they were. The attention of the Society might be called to a few points in gas-lighting which bore upon the subject. Too many burners were made with taps which opened both ways, and allowed a careless or nervous person to leave it open; whereas a tap made with a stop gave certainty, even to the most nervous person, that there could be no escape from that jet. The use of composition pipes in lengths, not exposed, was a source of explosion more frequently than a defective meter. The meter ought never to be in a building. Mr. Papworth had in his own house one which became full of little holes, as if pricked with a pin. Snakes, as the flexible tubes were called, were dangerous, as the pressure of the

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gas forced liquid caoutchouc out of the india-rubber tubes, which was, of course, equivalent to an escape of gas. Mr. Papworth had a gutta-percha tube which took fire at the union with the lamp; but he was fortunately present while the burning gutta-percha pipe was dropping on the floor. Gutta percha pipes, as sold for the purpose, did not withstand the usual pressure of gas. The bad setting of ranges and stoves was a fertile source of fire, and it was to be regretted that the new Building Act appeared to leave that point to the discretion of the surveyors of the insurance companies; also that it had not provided for the immediate division of the great buildings called by the owners themselves warehouses, which were so evidently built in evasion of the spirit and intention of the old Act. With regard to some observations made during the evening, the insurance companies would naturally feel complacent when a fire occurred, if not on property insured; the alarm produced an increased business to the offices. The companies divided large risks, both of life and fire among themselves; they could not rejoice in each other's losses. He eulogised the manner in which the Brigade attended any fire, without stopping to ask if the building was insured; and adverted to the improbability that even when the high-service water supply became the rule, the majority of houses already built and unsupplied would be furnished with it. He mentioned one case in which the bursting of a cistern on the high water service had sent 800 gallons of water down a house, destroying property by inundation to a greater extent than any fire that could have occurred there on the same day. He held that in most cases the sudden alarm would leave the inmates of a house, supplied with a continual high-service, as much in need of the services of the Brigade as they were at present. He bore testimony from his own experience to the rapid attendance of the Brigade at a fire next door to his own house, and remarking on the difficulty of disturbing the inmates, showed that few of the audience would have been able to have applied usefully the means which a high-service would allow. He admitted that the rapidity with which in Hamburgh fires might be extinguished of late years; and he described the attendance of the police at every double crossing in Paris and some French cities, with power to break open doors in case of fire; a permission given not only to the police, but to any person suspecting fire in some of the German towns, which he understood was the case also at Hamburgh. This was not the law in England, at all events in London, as the police had refused him permission to break a pane of glass, to pour a pail of water on the commencement of what he considered a case of incendiarism.

Mr. G. F. Wilson, F.R.S., said, Mr. Braidwood had given so many valuable suggestions, that it was difficult to add to them. There was, however, one mode of checking a fire to which he had not alluded, and which, in his (Mr. Wilson's) earlier experiences, he had found prove useful. Some of the largest fires had occurred in chemical manufactories, where coppers or other vessels containing combustible materials were set over fires in heated brickwork. In most of these factories there were steam boilers. If the simple precaution were taken of connecting a steam-pipe from the boiler to the flue round the copper, in case of a leak or other appearance of danger, on a cock being turned on, steam was admitted, which, immediately displacing the air from the flue, damped the fire. Mr. Braidwood had spoken of iron pipes being a common cause of fire. From inquiries he had lately made as to the breaking out of fires in manufactories, it would appear that clay pipes (?) were a still more frequent cause of fire. When brought in, with their contents only half extinguished, they set fire to the men's jackets, which, stowed away in corners, started a fire that might not be for some time discovered.

Mr. Hows said an objection had been taken that the present fire escapes were too cumbersome to be of service in courts and alleys; but he thought, amongst the scientific men now present, a machine adapted for those narrow localities might be designed; and he hoped it would have attention and be carried out.

The Secretary has also received some remarks upon spontaneous combustion, from Mr. G. F. Ansell, who says, "Amongst the causes from which large fires resulted, Mr. Braidwood mentioned spontaneous combustion, and although not a member of your Society, I was sorry to find that no one offered any point from which to discuss this subject. I would, however, beg to offer a few remarks, which, should they meet your views, may possibly interest some of your members.

"Some years since Prof. Dobereiner discovered that spongy platinum absorbed and condensed within its particles large quantities of oxygen, and that if a stream of hydrogen, alcohol vapour, coal gas, and sundry hydrocarbons, were allowed to flow upon this spongy platinum, a combustion ensued, evolving a very considerable heat. I do not go into details, but allude to facts for the sake of illustration. It has since been discovered that other substances possess this remarkable property, and I would now offer to explain, as no one else did, that the fact of oil and sawdust exciting combustion, may be due to this property existing at the same time with the extended surface presented by the sawdust. I have found that new cod liver oil and sawdust will enter into active combustion in about eight or ten hours, if considerable quantities (*e. g.*, a bushel of sawdust with as much oil as it will take up) be used. If for a moment you reflect upon the oxidation of alcohol in the manufacture of vinegar, as now practised by the agency of twigs, and the heat resulting, you will hardly be surprised at the heat under other circumstances being far greater. A curious case of spontaneous combustion occurred a few weeks since, and which certainly is not marvellous to chemists, but is astounding to those most interested, and which, perhaps, is new to yourself. A mass of iron filings and turnings had been allowed to accumulate at a large factory in this neighbourhood, and day by day were sprinkled with water in the process of laying the dust, previously to sweeping the floor. One night, after all the men had left, a fire broke out, which was soon arrested, but was most clearly traced to the spontaneous combustion of the iron turnings. It is known to every one that iron decomposes water, combining with its oxygen and liberating its hydrogen, and in this case I think that the grease generally attendant upon iron turnings was oxydised at the expense of oxygen condensed by the finely-divided metal, and so lent its aid in raising the temperature; and iron once heated burns with as much activity as tinder or old rags; but long before the heat reached this point the wood in the neighbourhood would have ignited."

The Secretary read several other papers which he had received during the course of the discussion, including communications from the "Fire-Annihilator Company," from Lady Bentham, Prof. Hosking, and Mr. W. B. Adams, the last of which we give in full, as follows.

ON FIREPROOF, NON-COMBUSTIBLE, AND FIRE-EXTINGUISHING BUILDINGS.

By W. Bridges Adams.

The building of cities might be, but is not, a philosophical process. They have usually grown out of accidental circumstances united with peculiar localities, not having reference to all the wants of man. The general requirements in a city are—good drainage, either natural or artificial; well formed and paved streets, with the minimum of dirt, and the greatest facility for walking and traction; complete ventilation, only to be attained by the streets being all thoroughfares, and the width of the streets being at least twice the height of the houses; convenient arrangements for warmth indoors; and absolute incombustibility in the buildings.

Walls are made perfectly incombustible of brick and mortar, but they are not incapable of destruction by the agency of burning materials, because, by the action of fire the mortar returns to its original condition of quick-lime. To be perfect, they ought to be of fire-stone or brick, cemented with fire-clay.

Floors may be made of groined brick arches, resting on brick pillars, but, to be indestructible by fire, they also should be built without lime mortar.

But such floors and supports would be a great waste of space; therefore, flat floors are required, either spanning from wall to wall, or supported at intervals by pillars of small size.

The only material of which flat floors can be constructed is, beams of iron, and wrought-iron in preference, as being many times stronger with equal bulk.

But inasmuch as iron is capable of being damaged by the combustion of burning material in contact with it, it becomes necessary to surround it with non-combustible material, capable of withstanding great heat.

The floors known as Fox and Barrett's are constructed of wrought-iron beams covered in with concrete. The thickness of the concrete is very important; but as lime enters into the composition, continuous heat of sufficient intensity would gradually destroy the iron.

Fire brick and clay in sufficient masses would render such a floor indestructible by fire.

The only objection to such floors is their great weight.

Where no mass of combustible material exists in the building, floors of sawn slate may be applied; the joints being caulked with elastic material. The roofs might be constructed flat on a similar principle, with great economy in structure, and with the advantage of adding another floor gratuitously, either as an open terrace, or to support a greenhouse. Between the ceiling and the slate roof air might circulate in warm weather, and be a fixture in cold weather.

The floors being hollow, would serve for the passage of air for warming and ventilation.

The staircases could be either of sawn slate or of metal bars built into the walls and covered with fire-bricks.

As regards warming, two classes of heat are required—warm summer heat, in the form of flowing air; and radiant heat, for warming the extremities of the body, or for the purposes of cookery. The heat that is healthy for the lungs is insufficient for the feet for those following sedentary employment.

No building can be healthy that is not warm and dry; and the conditions of dryness and warmth are precisely the conditions essential to rapid combustion and the destruction of combustible buildings by fire.

The Houses of Parliament, the Royal Exchange, and other public buildings, were burnt down, because, being combustible, they were unfitted to be warmed by the modern processes of heated air, which dried all the woodwork to a condition of tinder after being some time applied.

It is, therefore, important, even in a sanitary point of view, that all

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buildings be fireproof, and the same kind of dryness is also important in warehouses.

For the supply of warm air, it would be much better to produce it in a separate building, and supply it by meter to a whole neighbourhood, just as gas is supplied. This will probably be some day accomplished, and the air will be drawn from as great a height as possible, for the sake of purity.

For radiant fires, whether of gas, coal, coke, or other material, chimneys are essential. Chimneys, as ordinarily built, are formed of bricks, the horizontal joints of which are close, while the vertical joints are open, or only closed with a covering of what is called "pargetting," a mixture of mortar and cow-dung. The object of this is to prevent shrinking and cracking. Gradually the cow-dung burns out, the "pargetting" falls down in a crumble, the joints are open and draw air, the chimney smokes, and fire may thus get access to the floors.

To make accurate chimney flues, the interior should be lined with a flattened tube of iron or of pottery; if glazed inside, so much the better. Near the fire the tube should be of fire-clay; and wherever heat penetrates, fire-bricks and fire-clay should be used instead of ordinary bricks and mortar.

We occasionally see original bad chimney constructions eked out by tall zinc chimney-pots. In cold weather, the air is condensed within them, and forms a practical stopper to prevent the smoke from ascending. If these zinc pots were made double, with half an inch of air-space between them, the result would be a warm chimney, and this class of evil would be amended.

It is obvious that a building thus constructed might be roasted inside with any amount of gas or hot air without sustaining damage. The only fire must arise from the furniture.

It may be objected that the floors would be cold without boarding. But thin wood parquetry, saturated with non-combustible solutions, might be used to cover them. Neither this, nor woollen carpets, nor woollen curtains could aid fire.

Furniture, as chairs, beds, and couches, might all be of elegant iron-work. Table-tops might be of marble, slate, or metal. Linen, books, and other articles, could not be in sufficient quantities to aid combustion.

A building such as described, if built with solid floors, would be fire-proof. But an iron building, well constructed, though not fireproof, would be incombustible, and if furnished with incombustible materials, would be very desirable where ground-rents are dear, and space is limited, on account of the extreme thinness practicable with double walls of metal.

It may be remarked that this class of building will answer very well for dwellings, but would be useless for warehouses on account of the mass of combustibles.

Let us consider this question. Warehouse goods consist of explosive materials, rapidly combustible, and slowly combustible. Explosive materials, it is clear, should not be permitted at all in cities, and rapidly combustible materials should either be separated into small quantities, or the building in which they are placed should be isolated by fireproof external walls, from all other buildings. Bales of cotton, cylindrical in shape, and with air spaces between them, are among the most combustible materials, but woven cloth closely folded, books and paper in reams, and similar materials are very difficult of combustion.

There is no doubt that the most convenient form for a warehouse is four external walls, with the floors supported internally on columns, and central wells opening through them from top to bottom; and the larger the warehouse the more economical is the building. But the Building Act prescribes that it shall be divided by party walls into small portions, whatever be the class of goods to be warehoused. And even iron beams and columns are objected to.

The problem to solve is, to make the columns and beams fireproof, and to make the fires that may happen self-extinguishing. If the floors be formed with brick and fire-clay, and the columns be surrounded with the same material, and the brick surrounded with sheet iron, to prevent wear, that first object will be accomplished. There is no more difficulty in making the building fireproof than in constructing one of Milner's fireproof safes. The central wells should all be fitted with sliding iron trap-doors. The stair-heads should close with wrought-iron doors, the windows with wrought-iron shutters.

Nor is there any great difficulty in so arranging that the fires may help to extinguish themselves. The warm air, which should freely circulate in the day time, to keep the goods dry, should be cut off at night; and with closed doors and windows, if fire happened, it would probably suffocate itself. But we must also calculate for carelessness, the leaving open doors and shutters, and, therefore, other means must be provided.

On the roof capacious cisterns should be provided, with descending pipes communicating with a series of parallel horizontal pipes, or a network of pipes covering over and attached to each ceiling. From these ceiling pipes, say 3 inches in diameter, should project downwards, an inch or two apart, a series of fusible tubes hermetically sealed. In case of a fire, the fusible tubes would burn away with the ascending flame, and the water would pour down vertically on the flames and burning goods.

The roof cisterns should be connected with external pipes communicating with the street mains, under pressure, or with engines, which would thus become force pumps, carrying the water to the extreme height of the building. Thus, provision could be made for pouring water directly into the fire; and combings, like ships' hatches, being provided for the staircase and well, on each floor, with an exit pipe, no damage could be done by water running from the story on fire to those below it. Only that part would be drowned which it would be desirable to drown. Each floor would be like a huge tray holding a given quantity of water, with a waste-pipe to prevent it from running over.

Now, let us see what objections can be found to such a simple system.

First. That in process of time the pipes might become clogged with sediment. This might be guarded against by having exit cocks on every floor, and running off the water not every night or every week, but say on the first of every month. And as a further security no water should be used in the premises but that passing through the pipes. Daily necessity would thus ensure against neglect.

An illustration. A gentleman residing in the country had his house cisterns supplied with water by a force pump in a well. One cistern supplied the stable and garden; another the house, the groom and gardener having it in charge to fill the house cistern as well as their own. As a result, the house cistern was constantly empty, and the cook and other servants quarrelling with the groom and gardener. The master, after some change of servants and vain exhortations to regular duty on the part of the equine and horticultural representatives, bethought himself of going to the root of the evil. So sending for the plumber, he caused the whole supply to pass first into the house cistern and thence into the stable cistern. Nothing ever went wrong afterwards save in the time of frost. Neither groom or gardener could supply themselves till the house had its allowance.

With regard to frost. Water pipes burst. But there is a remedy for this. As a matter of course a very large warehouse has a watchman. For his own sake he will take care to have a good fire if he can get one in cold or frosty weather. If his only fire be the furnace fire, used to circulate the water in the pipes, which may serve to warm or partially warm the building, he will take good care to keep that fire going for the sake of his own pleasant sensations, and the constant warning of the pain of cold. This arrangement would certainly make a self-acting watchman, and there does not seem any reason why the apparatus should get out of order.

If cities were built on such a system, it is quite clear that there would very soon be an extinction of Fire Assurance Companies. The existence of risk is an essential principle to induce assurance, and without supposing that shareholders in such companies are worse men than their neighbours, it is evident that the continuance of a profitable business must depend on occasional fires to such an amount as will keep the general mass of building owners in an uneasy condition. Even mutual assurance companies cannot help being pleased with an occasional destruction of property—not involving life—which may bring grist to their mill. It is the very principle of competitive trade.

Fire insurance offices are, in short, either a silent satire on the human ignorance which erects dangerous buildings fitted for burning down, or an indication of poverty of power as regards capital, or poverty of invention, or both.

With regard to cost. If the legislature, deeming it right to guard human health from unwholesome buildings, as well as human life from dangerous buildings, should determine some day that all future buildings must be non-combustible, a great impulse will be given to the production of iron, brick, and stone, natural and artificial, and non-combustible buildings will come to be cheaper than combustible ones. They are, in fact, cheaper at present, if we take into account—insurance—doctor's bills—repairs—and inconveniences of all kinds; saying nothing of the process of being being burned in bed, and the concomitant taxes for fire escapes and other patch-work contrivances.

It is quite true that we cannot all at once get rid of our present dangerous buildings, but we can establish a principle, and, to a considerable extent, we can make it self-acting, by promoting the extension of non-combustible iron buildings in those situations where ground is costly, as in the city of London. For example:—Suppose a site 20 feet by 40 feet, and the four walls to be each 18 inches thick in brickwork, 20 per cent. of the area is lost, or about 170 feet out of 800 feet. If the walls be of double iron, and only 6 inches in thickness, the loss in area will be little over 6 per cent., or about 50 feet out of 800 feet, being a saving of 120 feet as compared with brick. If this be multiplied by five stories, we have a saving in space of 600 feet total, or nearly 67 square yards. When we think of the almost fabulous prices of city building sites, and multiply this result of one building by the whole of the buildings in the city, it is practically equivalent to the creation of so much new land—67 square yards on a base area of 89 yards.

This is a question very imperative for the consideration of the Metropolitan Board of Works, and the adoption of such a principle would give rise to new improvements in preserving iron from oxydation, and possibly to some new kind of compound metal, not subject to rust; at any rate to a cheap and effective process of bituminising, as a substitute for the miserable wash of zinc, called galvanising, which gradually disappears in a surface of red rust. The tin-plated roofs of Montreal and Quebec, flashing in the rays of the sun like a silver city of romance, are

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infinitely preferable to this. Tin is a metal not easily oxydised, and shelters the iron hermetically. Zinc being a metal easily oxydised, shelters the iron only by opposing its own substance to be devoured instead, as a kind of scapegoat. The oxydised zinc then rubs off, exposing a new surface, which is eaten in turn, till finally the iron is left exposed to the full action of the oxygen.

If we examine the various structures exposed to the continual action of fire, we shall find a locomotive boiler fire-box one of the most durable considering the intensity of the heat. In a case of necessity, for an absolutely fireproof building, it would be possible to attain it on this principle. With hollow walls, hollow floors, and hollow columns, all communicating and filled with water, supplied by an over-head cistern, the whole building would be water-clad. Consequently, any heat on the surface of the metal would be communicated to the water, and thus pass off without possibility of the iron getting heated up to the burning or melting point. The heat of the fire might thus cause the water to boil over at a certain level and put the fire out.

Examining the whole question of fire risk philosophically, we are constrained to regard fire extinguishers and fire escapes of all kinds, as mere temporary means or expedients to work on with a very imperfect system of building, and that our true policy is to work onwards as fast as we can, towards a perfect building system. We are fast abandoning combustible materials in ships, mainly induced by the greater internal space we can attain with iron, the greater safety from fire being only a contingency. Precisely the same principles hold good in crowded cities with high-priced land.

But as long as combustible buildings shall continue, there can be no question that the steam fire-engine is the best; and, if rightly constructed, the steam can be got up as rapidly as the horsing and water connecting, and other arrangements.

Mr. THOMAS PIPER said he had listened with great interest to the philosophical essay by Mr. Bridges Adams on the construction of buildings; but there were several little practical difficulties which had occurred to him as a practical man. With regard to the general suggestion, that arches should be turned in fire-bricks and with fire-clay the result of that would be that the arch itself would be insecure, because the constitution of the clay was such that when dry it would shrink, and leave each brick detached, and so destroy the arch itself. With reference to the glazed lining of flues, a patent had been taken out by Mr. Hiort for the construction of flues in a circular form, which could be built in any direction, the sides of the bricks being glazed. The objection to this plan was, that the glazing did not hold the soot, and at every shower of rain the drops came down the chimney with their load of soot and dirt, producing thereby great inconvenience and annoyance. He thought the object of the discussion was not so much to theorise on what they might do if they had the requisite materials, as to look at the buildings they did construct, and see how they could render them less liable to the objections which had been made against them. He would first speak to the observations of Prof. Hosking, who suggested that the evolution of gases caused timber more readily to ignite at its end. He (Mr. Piper) believed it would be found that when timber was heated to a point to become ignited, the great matter to support combustion was pure air, to supply the necessary oxygen; whilst, if they covered the inflammable material with a thin coat of plaster, it would be seen how the stoppage of the access of oxygen rendered the material incombustible. A perfect plaster ceiling, in the ordinary way, was a good stopper of fire. In a house of his own, in which the ground floor was burnt, the floor above the room in which the fire originated was uninjured, in consequence of the resistance which the fire experienced from the plaster ceiling; and if the ceilings were constructed in this country as they were in France, and as he had constructed them, under the instructions of Prof. Hosking, they would be still more resistant of fire. Instead of covering the bottom of the joists with thin lathing, and then putting on a ceiling pushed up from below, in France a moveable frame of wood was placed under the ceiling; on this two inches or more of plaster was put on and thrust through from the top; thus an incombustible surface was prepared, which would resist fire. As houses were generally constructed, the spaces between the floors and the joists, and the quarterings of the partitions formed so many flues from top to bottom, and greatly promoted the progress of fire. The flames, on catching the floor, passed through these flues so prepared for them, thence to the skirting, and thus communicated with every part of the house. The practical observation he would make was, that it was desirable to avoid lath and plaster partitions in houses, and also that the ceilings should be thicker and stronger than was the case at present. He believed that the disuse of wood skirting, in accordance with the views of his late friend Mr. Cubitt, would go far to prevent the destruction of houses by fire. The use of plaster for the decoration of doors, &c., would also do much to prevent the spread of fire, and by the improvements in making plaster by the introduction of Martin and Keene's cement, the building might be made more fireproof than was ordinarily the case. He had extensively used the method of flooring introduced by Messrs. Fox and Barrett. It consisted of wrought-iron joists I-shaped. Upon the lower flange were laid laths, and upon these laths concrete was placed, forming the floor. But he found this to result—when the concrete was all loose, each joist appeared to be isolated, but when the mortar became set and indurated, the whole then formed a perfect binding, and if it moved at all it moved together. He had seen these floors adopted to a large extent, and he believed it to be a most valuable invention. With regard to cost, which in this practical age was a most important one, any house could be constructed with this description of floors with the additional expense only of the flooring boards, that is, the cost would be enhanced by the amount of the value of the flooring boards only. Adverting to the communication of Mr. Bridges Adams, not only had Fox and Barrett's floors been extensively used, but the suggestion of Mr. Adams, of flat roofs covered with tiles, so as to form a terrace, had also been employed. But the point was this, when they had to contend with a large body of fire, it was found that cast-iron yielded, and wrought-iron was twisted, by the intense heat to which they were subjected. If a building were constructed in the manner suggested by their philosophic friend Mr. Adams, he doubted whether, under the amount of fire with which Mr. Braidwood was familiar, such a building would stand. The point, however, was not so much to attempt to govern a fire when it had got hold, as to give it so little food as to be managed in the apartment in which it originated, and prevent it from spreading. He believed that, by a very simple process, staircases might be rendered less combustible—that was by constructing them as they did in France, filling in the spandrels with incombustible material, instead of constructing them as so many hollow boxes. If the stairs were a solid mass, it would be a long time before the fire would act upon them in such a manner as to render them impassable. He would add one word with regard to the fire-annihilator. Mr. Braidwood had stated that an early and well-directed application of water to the spot immediately on fire was of great importance, and that if the water did not reach the spot on fire, it was useless towards extinguishing the flames; but the vapour from these machines would fill the whole apartment, and to that extent he thought there would be great benefit from their use.

Mr. BADDELEY desired to offer a few words in explanation of some of the remarks which were made either in Mr. Braidwood's paper or in the subsequent discussion. Before doing so, however, he wished to state that as, in his opinion, the statistics of fires furnished a most instructive lesson in the way of precaution, and suggested the best methods of prevention, he had prepared some tables illustrative of these matters, which he begged to present to the Society. On reference to the causes of fires, it would be seen that the five classes into which Mr. Braidwood had divided them included four-fifths of all the known causes of fire in the metropolis during the last twenty-three years. Carelessness in the use of fire and artificial light, and in the construction of buildings, occasioned a fearful number of accidents. At the same time, fires would sometimes occur in the most carefully conducted establishments from accidents wholly unforeseen, and, for the most part unavoidable, and in spite of the utmost precaution. A remarkable illustration of this fact took place in December 1853, in New York, at the premises of Messrs. Harper, printers, booksellers, and stationers. This firm having suffered severely by fire on a previous occasion, was particularly careful in rebuilding their premises, to take every possible precaution for the prevention of the recurrence of so dire a calamity. They had a steam-boiler in the basement, but, with this exception, no fire whatever was permitted in the building. The gas-lights were most carefully arranged; the building was warmed by steam-pipes; and the charcoal fires usually employed for heating the bookbinders' tools were replaced by gas jets. Constant care and watchfulness was the rule of the establishment, and a fire could hardly have happened but for one of those unfortunate accidents which render unavailing all human foresight. Camphine was necessary for cleaning the inking-rollers, but this operation was conducted in a room fitted up expressly for that purpose, and lined with zinc. Some repairs being required, a plumber had occasion to light a lamp, which done, he very carefully threw the match into what he took for a tray of water, but which unfortunately was camphine. The place was instantly in flames, and the whole of the premises, with their contents, valued at upwards of one million of dollars, were entirely destroyed. Spontaneous ignition would be seen to have occasioned upwards of three hundred fires in the period under review, being nearly twenty per annum. Although the fact of spontaneous combustion taking place in cotton, wool, hemp, lamp-black, and many torrified vegetable substances, was tolerably well-known at the close of the last century, we were still very much in the dark as to the peculiar laws by which these phenomena were regulated. Mr. Braidwood had stated "that there appears to be some chemical action between heated iron and timber, by which fire is generated at a much lower temperature than is necessary to ignite timber under ordinary circumstances." This fact was indisputable, but no satisfactory explanation of it had yet been given. The iron (chemically speaking) was by no means essential to the result, because it had been repeatedly observed that roasted bran, coffee, malt, and other vegetable substances, as well as coke, charcoal, and other matters, after being cooled down to such an extent as to be easily handled, had, when laid together in bulk, gradually increased in temperature, until they had eventually ignited. To this phenomena he had given the name of the accumulative property of heat, but could offer no satisfactory explanation of its cause. Mr. Marrable, at the last meeting, supposed that the timber was converted into "touch-wood" previous to

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ignition, but such was not the fact. The timber assimilated more to the character of charcoal, and ignition took place in these cases at a temperature much below the igniting point of either touch-wood or charcoal under ordinary circumstances. The greatest cause of fire was candles, upwards of four thousand fires having been thus occasioned in London since 1832. But this might have been expected, seeing that candles were almost in universal employment. The next prolific cause of fire was flues, then gas, and under these three heads alone more than half the total number of fires would be found. "The best means of arresting fires," was, as Mr. Braidwood justly observed, "a very wide question." He begged to differ, however, from Mr. Braidwood, when he stated that, "the only limit to the means is the expense," because he had for years past held the opinion that the *best* means of arresting fire would be the least expensive. He apprehended there could be little doubt but that with constant water service under pressure, with suitable arrangements for its prompt and efficient application, not only would the loss of life and property by fire be greatly diminished, but the early extinction of fires would be effected at a greatly reduced expense. Such had been the result of the adoption of this principle in Philadelphia, Hamburgh, Liverpool, Manchester, and other places, and such must be the results in London eventually. The present arrangements of the water supply in the metropolis were not yet such as to permit the direct jet from the water-mains to be entirely depended upon for extinguishing fires. At the same time these jets were much more available than was generally supposed. They were extensively used at the finish of large fires (as stated by Mr. Braidwood), and might with great advantage be still more extensively employed at the beginning of small ones. It was a very common occurrence for the firemen to find a fire burning in a cellar, or it might be in a shop, the whole of the fire being below or within ten feet of the ground. In such cases a plug was opened, capable of giving a twenty, or even a thirty feet jet, which was abundantly sufficient for the extinction of such a fire. Nevertheless, the engine was set to work, and in a few minutes the fire was put out. In some experiments that were tried on the Southwark mains and services some time back, seven-eighths inch jets from the service-pipes were thrown to a height of 30 and 40 feet, and jets from the mains to 50 and 60 feet. In many parts of the New River and East London districts, similar jets had been obtained.

Mr. ROBERT RAWLINSON, C.E., remarked, that Mr. Braidwood had said, "The Water Companies are generally willing to give any quantity of water, but they object to lay down large mains without any prospect of remuneration;" and further, that "plugs" were generally on small branches, and not on the mains, so that any available head was lost, or destroyed by friction. The practice of using water from the mains direct in Manchester was noticed, but was not considered applicable to the metropolis. Mr. Rawlinson stated that what could be done in a small town could be done more economically in a larger one; and after all, improvements to be useful must be economical. He felt satisfied that the water supply in London could be made as active as in Manchester or as in any lesser town. The question of extinction of fires was most important. It was one which, sooner or later, must engage the attention of the local governing bodies of the metropolis—and must involve an improved system of water supply. It appeared there was a dormant pressure of some 150 feet—that is—150 feet head; but, by reason of friction and exhaustion, there was little or no active head. Water under the present system would not rise from the mains more than a few feet. It was a question well deserving consideration, as to whether some means could not be adopted to make the present mains answer the purposes required. "Head" or pressure, was lost by length of main, by bends, and by any obstruction causing friction. A length of parallel main might have 150 feet head at one end, and might only have a few feet of working or active pressure for fire purposes at the other end. By the erection of what he would call towers or reservoirs of equilibrium, a more even, regular, and effective pressure might be established. The capacities of pipes varied as the squares of their diameters, and their delivery about as the square root of the head, minus friction. Water would, under the most favourable circumstances, rise through the atmosphere in a jet to a height of about two-thirds the head; that is, from 135 feet head, a jet should rise 90 feet. Friction would reduce this. Mr. Beardmore, in his valuable hydraulic tables, detailed experiments with pipes under several conditions as to diameter, length of main and head, giving the height of jet and volume of water discharged.

In Preston—from 6-inch main, head 110 feet.

	Height.		Discharge.	
With 1 jet ¾ inch	57	feet	12·5	cubic feet.
With 1 jet ¾ inch	64	feet	14·4	cubic feet.

The first being during the day, the latter during the night.

In Lancaster—from 8-inch main, head 225 feet.

With 1 jet an inch in diameter, the water rose to a height of 140 feet.

With 100 feet of common hose of 3-inch diameter, the water rose to a height of 80 feet.

Before water could be available under pressure, there must be proper fire-cocks or hydrants. He spoke under correction, when he said that fire-cocks were unknown in the metropolis. A rude wooden plug was driven into an open pipe end, and when water was required for use at a fire one or more of these must be drawn and the stand-pipe must be inserted in the face of the rising stream. Now fire-cocks could be put on the mains, and were in use in all towns where new works were established, which would perfectly command the water. A wine glass might be filled or a jet might be thrown over the adjoining houses. Proper hydrants or fire-cocks might be used for purposes of street-watering. They would be placed at short distances apart, and a water cart, with stand-pipe, key, and hose, could fill 250 gallons in 1½ minute of time; at present, carts for street-watering all over the metropolis, were filled at pumps; man, horse and cart, were delayed a quarter of an hour or twenty minutes to fill a cart, and then the same cart had to travel the same ground several times over full and empty. With hydrants a cart would be immediately filled at any point, and would never traverse useless ground, one cart under improved arrangements doing the work of three as at present, and at one-third the cost. Water in force, was more effective at a fire than where it was merely poured out over it; now force implied volume, and one jet from a street-main might have the force and volume of several hand-engines. The best fire engines did not throw water more than 95 feet high, and this in spray. A jet, could be made to rise from 100 feet to 200 feet and upwards. At some of the great cotton fires at Liverpool, it was only the force which knocked the fire out, and not the wetting of the materials. Force and volume of water might be obtained in the metropolis by a proper revision and improvement of the water mains and services.

Mr. BARRETT observed, that Mr. Braidwood had stated in his paper that *carefulness* was one of the best preservatives against fire, and no doubt he was right. He feared, however, that so long as we continued to construct the interior of our houses of a material so inflammable as timber, so long should we have to regret the annual loss of a vast amount of property, and to deplore the still greater evil of a large destruction of human life. It was remarkable that with so subtle and insidious an enemy as fire to deal with, we should still continue to provide, in the construction of our buildings, that description of *food* which was best adapted to that enemy's devouring propensities. But so it was; we were wedded to custom, and it was exceedingly difficult to break through long-established habits. The construction of fire-proof buildings was a subject that had certainly not received that degree of attention which its importance merited. Until within a comparatively recent period, very little had been attempted in that way. Some few of our more important public buildings, some of the mansions of the nobility, occasionally a warehouse, and perhaps a cotton, clothing, or silk mill, had been constructed upon a fireproof principle, namely, that known as the iron girder and brick arch system; but this sytem was not adapted for domestic buildings, nor was it altogether free from objections. It had been well said that the arch *never sleeps;* it was always exerting a strain upon its supports, which required to be counteracted, and although it was customary to use tie or tension rods for the purpose of resisting this lateral strain, these rods were not always employed, nor when employed were they always successful, and occasionally accidents of a most serious nature had occurred in buildings constructed upon this plan. He could instance many of these, but would refer to only one, that of a large mill in the North of England, consisting of five stories. One of the arches in the upper floor of this building had settled, or sunk, and it became necessary to re-construct it. In doing this, sufficient care had not been taken to strut or keep apart the girders upon which the arch was supported. They, in consequence, yielded to the lateral pressure of the adjoining arches, and the whole range of girders and arches gave way, and fell to the floor below. This floor also yielded to the mass of materials thus suddenly thrown upon it, and so on, in succession, every floor gave way, the entire building becoming almost instantaneously a mass of ruins, and killing twenty persons in its fall. This method of construction could not, therefore, be looked upon as free from objection, nor was it generally applicable. What was really wanted, he apprehended to be this—a method of construction that for all ordinary purposes should be practically fireproof; one that should combine great *simplicity* of construction with *economy*, so as not to exceed, in any great degree, the cost of a building as generally constructed; and one that should at the same time be applicable to all descriptions of buildings, particularly to those of a domestic character. The system of fire-proof construction, which he had been for many years engaged in carrying out, he believed fulfilled all these conditions or requirements. He would not, however, trouble the meeting with a particular description of the system, Mr. Piper having already been kind enough briefly to describe it. He would merely observe, that by the combination of wrought-iron joists and concrete, the floor of each room became in effect a beam of artificial stone, with ribs of iron, the structure possessing great strength and rigidity by the consolidation of these materials. The underside was ceiled much in the ordinary manner, and the upper surface adapted to receive the ordinary flooring boards, or such other finished surface as might be required. Mr. Braidwood had referred to a description of building with which there was confessedly some difficulty in dealing, namely, the large Manchester warehouses, and buildings of that class; but these were the exceptions to the rule—they were the units in the hundreds, even if they bore so large a proportion; and being exceptional cases, they required to be dealt with in an exceptional manner, and arrangements which would be quite unnecessary in buildings of

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an ordinary character might be adopted with great propriety in these. He thought that in all cases the roofs of such building should be constructed of solid incombustible materials, and that there should be as few openings in it, for skylights or other purposes, as possible—such as were absolutely necessary being, in all cases, double-glazed. A roof so constructed might readily be formed into a tank containing a large supply of water (a plan which had indeed been carried out upon this system some years ago), or cisterns might be formed, as Mr. Adams had suggested in the communication he had made to the meeting. From the reservoir of water thus obtained pipes could be brought down in the corners of the rooms, or most convenient situations, these pipes being furnished with stop-cocks or valves at the level of each floor, where a hose might be permanently attached, affording a supply of water at all times, which by merely turning a cock could be thrown in any direction in the event of fire. If, in addition to these precautions, the floors of the building, instead of being constructed of timber, as was generally the case, were formed of incombustible materials, ten or twelve inches thick, he thought there would be little to apprehend in case of fire. It should be remembered, also, that the fire itself generated an atmosphere which would not support combustion. A fire would burn but slowly till it had succeeded in burning a hole in the floor, when, getting a ready supply of air, and meeting in the floor itself with the requisite fuel, it would extend with great rapidity. But the case was very different when the supply both of air and fuel was cut off, which would be the case with floors such as he had referred to. He had observed in several instances, in the case of buildings constructed upon his system, where fires of coal and coke *laid upon the surface of the concrete* had been kept up for weeks together, for the purpose of drying the plastering of the walls, that the difficulty always was, not to put the fire out, but to keep it in, the attendant being constantly employed in going round the building, and stirring up the fires, to prevent their going out. Although in buildings with very large areas without vertical divisions, it might not be possible under all circumstances to prevent serious damage being done, he thought the evil might be very much mitigated; for he felt convinced that in those cases referred to by Mr. Braidwood, where so intense a heat had been generated as even to fuse cast-iron, it had arisen from the fact of the materials of which the building was composed themselves affording the fuel necessary to produce the degree of heat.

ON TIDAL RIVERS.

By Joshua Wilson, Sunderland.

A tidal river with lateral indents admits of a natural separation into two divisions—viz. the channel, or river proper; and the lateral indent, or estuary portion. The channel is wholly due to the alternate scour of the flood and ebb tide, the latter including the land water. In many of our tidal rivers, a long continuance of dry weather causes a reduction in the depth of the channel, through an accumulation of deposit, which is scoured away on the recurrence of a land flood. But from the large quantity of silt deposited by these floods in the lateral indents, where it is not exposed to the direct action of the current, it becomes a question whether the cubical contents of the estuary, viewed as a receptacle, are not reduced thereby. If the land flood should be powerful enough to neutralise the action of the flood tide, there will also be a deposit where the ebb forms an eddy; but since this portion of the channel must necessarily be exposed to the scour of the flood tide, the silt will again be set in motion on the subsidence of the freshet, until it is finally carried out to sea or deposited in some portion of the channel due to the scour of the land flood. Thus the alternate action of the flood and ebb tide maintains a larger sectional area of channel than would be due to the scour of the ebb alone.

The process by which the silt deposited in the lateral indents is brought within the range of the river current, being of a more complicated description, requires a more lengthened notice. This movement is usually ascribed by engineers to the lash of the waves. In order to test this assumption, we will suppose a lateral indent recessed from the river channel, and that a breeze of wind is blowing into the bight; the lash of the waves will disturb the mud, but during the period of the flood tide it will be removed further from the river channel, and this on-shore movement will be little more than counterbalanced by the action of the ebb. As a set-off to the inclination of the bed of the indent, there is the accumulative action of the on-shore wave.

In the off-shore current which is produced by an on-shore breeze, may be recognised an agent which, during the whole period of the tide, imparts an off-shore movement to the mud disturbed by the lash of the waves. As the existence of this current has not been generally recognised by engineers, it is but reasonable to expect that evidence shall be adduced in proof thereof, as well as into the nature of its origin, and the laws by which it is regulated.

The late John Smeaton observed, that in a canal four miles in length, a moderate breeze along its surface raised the water at the lee end four inches above its ordinary level, and depressed it four inches at the weather end, making eight inches difference in the vertical height between the lee and weather ends of the canal. Now, this accumulation would destroy the equilibrium of hydrostatic pressure at the bottom, thereby causing an undercurrent to set towards the weather end.

Any one who may wish to satisfy himself of the existence of this current, upon stirring up the mud at the bottom of a pond on the lee side, when there is a breeze sufficient to produce a ripple on its surface, will perceive the lower stratum of discoloured water moving to the windward, with a velocity proportionate to the strength of the breeze. It is a fact well known to sailors, that if they are caught by an on-shore gale of wind off the coast of Holland, and they can only keep their vessel from going ashore for a few hours until this off-shore current is produced, there will then be little danger of such a catastrophe. A strong westerly gale on that coast often raises the surface of the water in-shore several feet, which consequently imparts considerable strength to the off-shore current.

The action of this current is mostly limited to the impartation of an off-shore movement to such detritus as may be disturbed by the lash of the waves; and its transporting power is dependent on the strength of the breeze, the breadth of the expanse, and the inclination of the shore.

From the greater expanse of the ocean, this current possesses a greater transporting power on the sea coast than on that of an estuary. Thus the shore of an estuary will be covered with mud, while, with a like inclination, sand or small gravel will be met with on the sea coast; and where sand will predominate in the estuary, a like slope on the sea shore will show a predominance of rough shingle.

A wave in an on-shore gale moves sand and shingle with equal velocity and power; but it is dependent on the strength of the gale and the inclination of the shore, as to whether the off-shore current acts on the sand and shingle, or imparts a seaward movement to the sand only. So, after an on-shore gale, we will often observe rough shingle piled upon the shore at a greater elevation than before, by the accumulative action of the waves; the size of the shingle enabling it to resist the action of the off-shore current.

In order to illustrate the effects of embankments in impeding the action of off-shore currents in estuaries, we will suppose there is a lateral indent deeply recessed from the river channel, with its bed sloping down to low-water-mark, and that a neighbouring landowner, in order to enlarge his estate, obtains leave to form an embankment across it near half-tide mark; and that it is stipulated in the arrangement, in order that no tidal water be excluded thereby, that the shore in front of the embankment is to be excavated to the low-water-level, and the material thrown behind it; on its completion, there will be no exclusion on spring, and an enlarged receptacle for the water of neap tides. But the question arises—Will this tidal receptacle so formed remain undiminished in size? Since there will no longer be any sloping shore to the river channel in its altered state, the disturbing power of the waves will be lost, and with it the action of the off-shore current; so that a deposit will accumulate in front of the embankment, and from the breadth of the expanse being decreased, before this current can resume its functions in returning all deposits to the river channel, so as to be acted upon by the passing current, a greater slope will be required than before the embankment was made. But before this takes place, the indent will be reduced to about half its original size.

If half-tide walls on the sides of a river channel are raised above the level of the shore behind, the detritus will accumulate until it forms a slope from the high-water-mark to the top of the walls, when the off-shore current will again be brought into action so as to prevent any further accretion. Foreshores will also form in front of these walls if they are not exposed to the direct scour of the river current, and the scour will be further reduced by the exclusion of tidal water consequent on these changes.

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NEW METHOD OF APPLYING AND CONDENSING STEAM.

By THOMAS PROSSER, C.E., New York.

*Memoir:—On a new method of Applying the power of Steam, and of Condensing the same after it has been so applied; the former is designated the Differential system of Steam Power, and the latter the Hot Water system of Condensation.**

THERE are two methods of applying steam as a motor, the *positive* and the *negative*; to which I purpose to add a third, and to call it the *differential* method.

In the first or Positive method, the steam drives the atmosphere before it, and then loses itself entirely in it, without leaving a particle of the heat by which it had been created, to be returned into the boiler; all is lost after it has left the cylinder, and this constitutes the high-pressure non-condensing engine.

In the second or Negative method, the principal use of the steam is to negative or remove the pressure of the atmosphere; the pressure of the steam may be insufficient to overcome the friction of the engine, and therefore the air-pump is the real motor and acts as a *tug*; this is the low-pressure air-pump condensing engine.

Many persons appear to suppose that the simple injection of cold water into the condenser, sets and keeps the engine in motion at a very small expense, and that the air-pump refrigerator is not much of a tax upon the power of the steam; but good authority shows that it is an enormous one Dr. Ernst Alban says,[1] that "out of 17 lb. total pressure, only about 7 lb. are made available for useful effect."

Nothing, indeed, is necessary, but the presence of a desiccator, to make the air-pump condenser a complete freezing machine. Dr. Haycraft has some observations[2] on this subject in connection with surcharged steam, which are important as showing how the cold is produced and reproduced in the air-pump condenser.

By the Negative system of using steam, the feed-water is taken in at a higher temperature, so as to save from 4 to 5 per cent. of the fuel necessary to convert it into steam; this is really a very small affair, only about enough to work the air-pump itself while the great refrigerator is causing vaporisation,[3] and consequently producing cold to an enormous extent. But let that pass, while I proceed to show some of the advantages of high-pressure steam.

There is more heat in the same weight of steam at a high pressure, than there is at a lower one; nevertheless, its density is not increased in the same ratio as its tension.[4] For example, steam at 230° Fah. has an elasticity of 42·3374″, and a total heat of 1152° Fah., while steam at 356° Fah. has an elasticity of 297·1013″, and a total heat of 1190°·52 Fah.; so that, while the total heat has increased 1·03343 times, the elasticity has increased 7·01747 times, but the density[5] has increased only 5·93184 times, clearly showing that, whatever saving there may be in heating the feed-water by the condensation of the steam, it is far inferior to the gain by the application of high-pressure steam, for while the former is only from 4 to 5 per cent., that of the latter is

$$14\tfrac{1}{2} \text{ per cent.} = \frac{7{\cdot}01747}{1{\cdot}03343 \times 5{\cdot}93184}.$$

I do not purpose to go farther into this investigation now, as I have sufficient data for my present purpose.

The points now arrived at, are these, that there is a saving by using high-pressure steam, on account of its elasticity increasing faster than the sum of its density and total heat, and that when such steam has a pressure of about 297″ of mercury, the gain amounts to 14½ per cent.; also, that the small saving effected by pumping the feed-water into the boiler of an air-pump condensing engine at a somewhat increased temperature, is fully counteracted by the power necessary to work the air-pump.

If, therefore, in our calculations, we omit for the present, all considerations of the additional heat given to the feed-water, and also the loss caused by excessive condensation in the cylinder of the air-pump condensing engine, we may readily obtain a general expression, which will represent the economic value of that method of applying steam at any pressure, and which, at the same time, is equally applicable to the Positive and to the Differential methods.

The Differential method consists simply in using steam under two different pressures, the one in the boiler and the other in the condenser.

In the case of steam at 356°, I would have the labouring power = 255″ (= 297″ − 42″), and of course the exhaust steam at 230°, which will heat the feed-water to 221°, so that 970° (= 1191 − 221) must be restored in the boiler to the feed-water pumped into it from the condenser.

In the Positive method of using the same steam, the labouring power will be = 267″ (= 297″ − 30″), because of the removal of the 42″ of *lively* back-steam pressure, and the substitution of 30″ of *dead* atmosphere therefor.

Now, the decreased power caused by using the steam in the manner which I have proposed is from 1· to ·955056 $\left(=\frac{255''}{267''}\right)$; but it is also the cause of the increased temperature of the feed-water from 60° to 221°, the advantage of which is as 1·176**2**9 to 1·

$$\left(=\frac{1141}{970}=\frac{1191-50}{1191-221}\right).$$

The sum of these two values is 1·12342 (= ·955056 × 1·17629), which shows an increased economy of 12⅜ per cent. by using the steam Differentially instead of Positively; and as the latter has an advantage over the Negative of 14½ per cent., the Differential method has, of course, the advantage of a gain of 28·602 per cent., which is the sum of the two values. But even this, 28⅝ per cent., is quite below the real saving in fuel, for in addition thereto the boiler is always clean and free from scale, which is another source of economy in fuel, as well as a great saving of time and hard usage, which other boilers are subjected to in scaling; so that there can be little doubt as to the saving in fuel alone being fully 30 per cent. in land engines, and more than 60 per cent. in sea-going steamers, for I have excellent authority for stating that the saving by using fresh instead of sea water is 25 per cent.

But, to return to the question of a general expression, which shall represent the three methods of using steam, I suggest, that

$$\epsilon = \frac{p-p'}{(t-t')d'}$$

where p is the pressure of the steam from the boiler upon one side of the piston, p' the pressure of the exhaust steam on the other side thereof; t, the total heat in the steam p, above 0° C., t' the temperature of the feed-water, and d the relative densities of the steam p. Surely no test more severe than this, can be desired against the Differential method. I shall use the Centigrade scale of temperatures, as being more convenient than the Fahrenheit, and in all respects conform as nearly as is practically desirable to the authority I have referred to.

The relative density of steam, therefore, will be represented by

$$d = \frac{p}{t+272{\cdot}479},$$

which is of the same value as the equation given in *Note* (5), the change in the constant number being necessary on account of the adoption of the Centigrade, instead of the Fahrenheit scale of temperatures.

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* From the 'Journal of the Franklin Institute.'

[1] 'The High-Pressure Steam-Engine investigated' by Dr. Ernst Alban, translated by William Pole. London: J. Weale, 1847. p. 58.

[A review of Dr. Ernst Alban's work on the 'High-Pressure Steam-Engine,' will be found in the C.E. & A. *Journal*, Vol. x. (1847), p. 45.]—ED.

[2] Repertory of Arts (3 S.) vol. xii., p. 25, (1831), and London Mech. Mag., vol. liii., pp. 288 and 302, (1850), wherein the Doctor very handsomely acknowledges some former errors, but makes a promise which, I am sorry to say, has not been entirely fulfilled. The engine was exhibited in 1851, but the results are not known to me.

[3] Vaporisation in a vacuum takes place at 68° Fah. according to Ginelin (Cavendish translation, vol. i. p. 271), so that the water in the air-pump condenser is boiling away and carrying off the heat just the same as that in the boiler, but not quite so usefully.

[4] Ginelin, vol. i. p. 259, gives the temperature 163° C., elasticity 3·571 met., actual density 443·32, density corresponding to the elasticity 714·2, showing a difference of 270·88, which is a gain of 61 per cent.; from which, however, must be deducted the amount of heat which, according to the text, exists in high-pressure steam more than in that of a low pressure, and that leaves a gain of 48½ per cent.

"The higher the temperature, the greater is the difference; hence the advantage of high-pressure steam-engines."—*Despretz.*

[5] The authority for the temperature, pressure, and other physical properties of steam is M. Regnault, in the 21st vol. (1847) of the Mémoires de l'Academie Royale des Sciences de l'Institut de France, a translation of which may be found in the 'Journal of the Franklin Institute,' vols. xv. xvi. xvii., Third Series. There is also a very meagre translation by the Cavendish Society (1848), concluding with the Ninth Memoire (there being ten in the original), and containing an error in the last column, which gives the "total heat above 32° Fah.," instead of above 0° Fah. The density of steam I have calculated on the supposition that 490°·463 represents the number of degrees necessary to double the pressure of air from 32°, and that steam obeys the same law. If, therefore, p = pressure, and t = temperature, we have

$$\text{the relative densities} = d = \frac{p}{t+490{\cdot}463}.$$

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The economic value of the fuel will then be represented, as before stated, by $\epsilon = \frac{p - p'}{(t - t')d}$, but, for greater perspicuity, I shall insert the whole of the numerals in the equation, and, adopting the Negative method of using steam as the initial of value, working with steam of 1·415 atmospheres pressure, and 110° C. of temperature, with a total heat of 640° C., the condenser being at ·155 atmospheres pressure, and the feed-water at 10° C. of temperature,[6] we have,

Lbs. per square inch of pressure above the atmosphere.	Degrees C., of the working steam.	
6	110	Equation No. 1—Negative. $1 \cdot = \epsilon = \frac{1{\cdot}415 - {\cdot}155}{(640 - 10),\ \overline{1{\cdot}415\ 110 + 272{\cdot}479}}$
75	160	Equation No. 2—Positive.[7] $1{\cdot}03715\ \epsilon = \frac{6{\cdot}120 - 1{\cdot}}{(655{\cdot}3 - 10),\ \overline{6{\cdot}120\ 160 + 272{\cdot}479}}$
55	150	Equation No. 3—Differential. ·99929 $\epsilon = \frac{4{\cdot}712 - 1{\cdot}415}{(652{\cdot}2 - 105),\ \overline{4{\cdot}712\ 150 + 272{\cdot}479}}$

These coefficients of ϵ all represent about equal values, and the table gives the necessary pressures above the atmosphere for the steam to be used in each case, to work with equal economy of fuel, at 6 lb. for the Negative, 75 lb. for the Positive, and 55 lb. for the Differential methods; a result which few probably would have anticipated under the circumstances, for, not a single advantage is given to the Differential method, while every disadvantage has been omitted that might tell against the Negative, as well as against the Positive ones.

If we allow about 15 per cent. of waste by condensation in the cylinder of the air-pump condensing engine, making the initial of economic value = ·85 ϵ, we shall find, that, to work with equal economy of fuel, both the Positive and the Differential methods will require the steam to be 38 lb., when on the Negative method it is 6 lb. above the atmosphere.

I will now show the economic value of each method under a pressure of 131 lb. to the square inch above the atmosphere.

Lbs. per square inch of pressure above the atmosphere.	Degrees C., of the working steam.	
131	180	Equation No. 4—Negative. $1{\cdot}26484\ \epsilon = \frac{9{\cdot}929 - {\cdot}155}{(661{\cdot}4 - 10),\ \overline{9{\cdot}929\ 180 + 272{\cdot}479}}$
131	180	Equation No. 5—Positive. $1{\cdot}1559\ \epsilon = \frac{9{\cdot}929 - 1{\cdot}}{(661{\cdot}4 - 10),\ \overline{9{\cdot}929\ 180 + 272{\cdot}479}}$
131	180	Equation No. 6—Differential. $1{\cdot}2899\ \epsilon = \frac{9{\cdot}929 - 1{\cdot}415}{(661{\cdot}4 - 105),\ \overline{9{\cdot}929\ 180 + 272{\cdot}479}}$

It thus appears, that, if the Negative method is practicable, there will be a gain of 26½ per cent. in using steam at 180° C., instead of 110°

In like manner, the Positive method shows an advantage of 15½ per cent., but in both cases the gain results from the increased pressure.

In the Differential method, on the contrary, the gain of 29 per cent. results from the increased temperature, both of the working steam and of the feed-water, the latter being the chief feature of the system; the gain by the former is 15½, and by the latter about 13½ per cent.

High-pressure steam with the Negative method is out of the question, for the innate disadvantages become too glaring; the enormous proportions of the air-pump and condenser must be increased, and the condensation in the cylinder will be increased in a still higher ratio, on account of the increased difference in temperature between the exhaust and the working steam.

No one will, I trust, deny that thus far I have shown the Differential system to be far superior at every point to the Positive method, and fully equal at moderate pressure even to the Negative one, while it is more than equal to it at high pressures,—if, indeed, that be practicable at all on the Negative system. And now, what shall we allow for the loss of power by condensation in the cylinder of the air-pump condenser, and other causes? And what shall we allow of useful effect on the Differential plan? Dr. Ernst Alban (p. 85), says, that the former returns but 41·2 per cent. of useful effect, while the ordinary high-pressure engine returns 75 per cent.; others make the difference still greater, but I am content to take 50 per cent. of useful effect as resulting from the Negative method, and 73½ per cent. for the Positive one. The proportions of useful effect are, therefore as 1 to 1·465 $\left(=\frac{73{\cdot}25}{50}\right)$ showing a gain of 46½ per cent. as due to the economy of high-pressure steam, superadded to the loss by condensation in the cylinder of the low-pressure air-pump condensing engines. To this we must add the gain of 13½ per cent., which results from the Differential method of using the steam, and which is an entirely distinct source of gain, and consists in feeding the water into the boiler at a higher temperature. Therefore, 1·60 (= 1·465 + 13½) represents the economic value of the Differential method, when 1 represents that of the Negative one. In other words, the useful effect of the fuel is 60 per cent. in favour of the Differential method of using the steam, even in the ordinary land engine. For sea-going steamers, the saving of fuel is 25 per cent. more, making a gain of 100 per cent.

If, then, these calculations prove correct (and their simplicity almost forbids the possibility of error), there can be no manner of doubt that the Atlantic may be crossed by steamers adopting the Differential system, with less than half the fuel now usually consumed. A transatlantic steamer of the largest class will consume 1600 tons of coal per voyage out and home, on the average of the year round. This coal really costs, to get it on board, and to get it off again, together with the useful space occupied by it and the boiler, and by the whole apparatus for its consumption, not less than $20 per ton,[8] or $32,000 per double voyage. The half of this expenditure I propose to save, simply by consuming but half the quantity of fuel to produce the same effect; and on the half so consumed, I propose to save half the space occupied by the boiler, and also half the cost thereof (as they will last double the time), making $2·50 per ton on 800 tons, or $2000 more to be added to the half of $32,000, showing thereby a saving of $18,000 on every single voyage hence to Liverpool and back.

As much depends upon showing that there is a great loss by the use of the air-pump, which causes condensation in the cylinder, I may be permitted to return to that point again. Not that the Differential system is less the true one, even without that proof, but because that alone is necessary to put the matter beyond dispute or conjecture. If any power can be gained by the use of the air-pump, nay, if it is not the cause of an absolute loss of power, it is quite different to all other mechanical action, which is ever reduced in power by a transfer to a secondary object, just as the steam-engine may and has been used to pump up the water to operate a water-wheel, but, of course, with the loss of power due to the friction of both combined. When

[6] The feed-water, as before stated, is taken at the natural temperature, the same as in the Positive method, for the reason that at whatever higher temperature it may be, the advantage is absorbed in working the air-pump.

[7] I have taken the nearest decade of temperature in the Table at the end of the Nintn "Memoire," to avoid unnecessary trouble in the calculations. The slight variations in the results are of no impotance whatever.

[8] Cost of one ton of coal, with labour to put on board, to consume it when on board, and then throw the ashes overboard .. $7
Value of space occupied 8
Space occupied by boiler to consume coal 2
Cost of so much boiler 3
$20

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the steam has forced the piston to the end of the stroke, and is suddenly condensed, the same operation is going on upon the metallic surfaces open to the condenser, to wit, the cylinder and the piston on one side or the other, so that when the steam is again let in, these cooled surfaces must necessarily condense a large portion of it, by many estimated at fully one-half. By working expansively, however, as soon as the steam is cut off, the reduced pressure causes the water in the cylinder to re-boil, and the surplus heat contained in the steam when of higher pressure takes it up, and hence the indicator gives no record of the fact. If the commonly received notion is correct, we get a mechanical something for nothing, and are in the neighbourhood of perpetual motion.

Dr. Ure employed the vacuum formed by the condensation of steam in a separate vessel, to produce attenuation and consequently refrigeration of the air under a receiver, and thus dispensed with all mechanical power to pump out the air; but it never entered his head that it cost nothing to do it, nothing in fuel. The waste by air-pump condensation is pretty well ascertained by the gain in using surcharged steam, for that gain can be but the absence of a portion of the waste referred to, just as a very bad boiler may be proved to be a paragon of perfection when compared with another infinitely worse.

The anomaly of reducing the temperature of the water resulting from the condensation of the steam, for the purpose of having to heat it again, under the impression that the removal of the pressure of the atmosphere can by any possibility be an equivalent therefor, is quite contrary to all analogy and sound argument. Need I adduce any other proof against the value of the Negative method, than the fact, that no one thinks of using high-pressure steam in such a manner, when there can be no objection to doing so if the principle is right? The already enormous proportions of the air-pump and condenser must be vastly increased, the condensation in the cylinder will be increased also, in proportion to the increased difference of temperature between the working and the exhaust steam.

By the Differential method, the cylinder is instantly exposed to a temperature of 105° C. when opened to the condenser, being a difference of 75° C. (180—105), while the air-pump condenser is usually about 46° C., showing a difference of 64° C. (110—46), although the pressure of the steam is but *one-seventh*. In Hall's surface condenser the difference was not less than 94° C. (110—16), and so of other surface condensers to be equally as good as his was; however, the condensation in the cylinder is considerably increased thereby.

Nor must we pass by the amount of condensing water used, which in the surface condenser of Hall, amounted to 300 lb., to condense 5 lb. of steam per minute with 58 feet of metallic surface,[9] *i. e.* 60 lb. of condensing water to one by weight of steam condensed, which is nearly double the amount used by Watt,[10] and *twelve times* as much as is required on the Differential plan.

That the condensation in the cylinder is very great, no one has ever denied—of its amount, however, I have only represented the opinions of others, and do not rely on them, but shall content myself[11] in ascribing it to no other cause than the simple difference of temperature between the working and the exhaust steam. We shall thus get rid of all the *mystery* which attaches to the case. From my own experience of the working of the Differential system, I am satisfied that the amount of condensation in the cylinder does not exceed 2 per cent., if indeed it is as much. This will give 12 per cent. for condensation in the cylinder of an injection air-pump condenser, and nearly 18 per cent. for Hall's air-pump surface condenser, which is most decidedly the best of its class. The Differential method has in the above calculation, seven times the pressure of steam, and seven-sixths the difference of temperature of the injection Negative method, and hence, the latter must condense about six times as much as the former, while the air-pump surface condenser must condense nearly nine times as much. It is well known that Hall's condenser did not economise fuel to the extent that was calculated upon; and I would ask, may not this statement account for it? Adhering to my modification of Dr. Ernst Alban's statement, that 50 per cent. can be obtained of effective power from the condensing air-pump engine, while 73¼ per cent. is obtainable from the non-condensing one, we have a loss of power,

	Negative, by Injection.	Negative, by Surface.	Differential.
Condensation in the cylinder	12	18	2
Friction and all other causes	38	38	24¾
Loss per cent	50	56	26¾
Effective working power	50	44	73¼
	100	100	100

That the "friction and all other causes" on the Negative plan, will be much more than I have allowed, as compared with the Differential one, I believe will be readily granted, when it is considered that the diameter of the piston and the stroke also must be doubled to obtain the same power. I think this method of accounting for a well known fact, is much better than introducing any imaginary ones, however ingenuous, into the argument, as some have done in regard to surcharging, and other methods of using steam, which can effect nothing more than the prevention of condensation in the cylinder. But the views which I have suggested, do not in the least detract from the advantages claimed for the Differential system, but I do not wish to undertake the defence of anything except the Differential system.

In my method of condensation, I use three annular surface condensers, each in its own cistern. The bottom one distils the water to make up for waste. The cistern first receives the *cold condensing water*, which becomes somewhat warmed therein, and then enters the *main condenser cistern*, where it is made to boil before leaving it as *waste*; but a portion of it, forming vapour, goes over and down into the *distilling condenser*, and thus becomes condensed and is collected, as is also that from the *main condenser* by means of a pipe from the bottom of each, passing through the bottoms of their respective cisterns to pumps, which force the water through the sides of the *cistern* above into the *heater condenser*, and from thence into the boiler, having become heated by the exhaust steam, which first enters at the bottom of this upper or *heater condenser cistern*, and after having performed its office of heating the feed water, goes into the *main condenser*, and the water resulting from its condensation is collected as before stated. The *bottom condenser* then (to recapitulate), receives the vapour from the *main cistern* to make up for waste and other purposes, the *main condenser* receives the exhaust steam and the *heater condenser* the water from both, while the cistern of the *heater condenser* receives steam only, and the other two cisterns condensing water only.

The *main condenser* has a pipe from near the bottom, which, when open, allows the engine to work without condensation, or, it may work with condensation, and yet no steam escape if the supply of condensing water is sufficient. In case, however, it is required that the *still condenser* shall be brought into full operation to make up for the extraordinary waste, this pipe must be closed, and then the water in the *main cistern* commences to boil rapidly, and the vapour therefrom goes over into the *distilling condenser* as before stated.

In concluding this part of my subject, leaving for another opportunity the means by which I purpose to render steam of any pressure far safer than the ordinary steam which is now used, in addition to that of a certain supply of water which the Differential system insures, and which shows so markedly its immense advantage over all others in that, the point of greatest importance to a boiler, inasmuch as it is not only self-feeding with regard to the steam condensed, but it has also a source of supply always in action, to make up for waste, which no other condenser has (except by a separate apparatus); I will observe, that the Differential system does not require the amount of back pressure which I have assigned to it, unless boiling hot water or steam is required in abundance for culinary or other purposes. Where, however, this is the case, and the whole heat can be usefully applied for drying-stoves or such purposes, more than half the fuel used under the boiler may be economised through the medium of the hot water or steam, or both, being passed through attemperators or other apparatus for that purpose.

I will, therefore, now show the comparative economic value of the Differential system, when working in ordinary, and only producing as much distilled water as will make up for the waste of the engine and its boiler, premising, that none of the steam

[9] Tredgold on the Steam Engine (1838), p. 371.

[10] Farey on the Steam Engine, p. 593.

[11] I do not mean by this to disparage any of the authorities whom I have quoted, but only to avoid the possibility of error in my calculations, by taking nothing for granted which is not thoroughly recognised: and, therefore, I apply to this case the rule laid down and universally admitted, that, the rate of cooling is directly as the difference of temperature. This rule, however, only applies to dry gaseous bodies; where moisture is present in the cooling medium, the effect is greatly increased, and this in fact is the case under consideration, but for the reasons stated, I abandon this source of advantage to the Differential method, in these calculations, to avoid abstruseness, as I can well afford to do, where the gain is so great without it.

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which condenses in the cylinder or exhaust pipes is allowed to enter the condenser, but goes to waste.

Lbs. per square inch of pressure above the atmosphere.	Degrees C., of the working steam.	
131	180	Equation No. 7—Differential. $1{\cdot}34593\ e = \frac{9{\cdot}929 - 1{\cdot}045}{(661{\cdot}4 - 105),\ 9{\cdot}929}$ $\overline{180 + 272{\cdot}479}$

Here, then, we have a gain amounting to 34½ per cent., of which 15½ (see Equation No. 5) is due to the high pressure, and 19 to the Differential system of applying the steam.

For the Western waters, where people are not easily frightened by a name, I would recommend steam of not less than 200 lb. to the square inch (and the same for locomotives, but not for ordinary boilers be it remembered), and then the following equation may serve:

Lbs. per square inch of pressure above the atmosphere.	Degrees C., of the working steam.	
211	200	Equation No. 8—Differential. $1{\cdot}42354\ e = \frac{15{\cdot}380 - 1{\cdot}181}{(667{\cdot}5 - 102),\ 15{\cdot}380}$ $\overline{200 + 272{\cdot}479}$

In this example, the working steam is supposed to be at 200° C., and the condenser at 105° C., while the feed water is at 102° C., and the main condenser cistern or "hot well" at 100° C.

It is useless to inquire further into the workings of the Positive system, because its great inferiority, except at about 38 lb. above the atmosphere, has been fully shown before. It is true, however, that this system does admit of a higher temperature being given to the feed-water through the medium of the exhaust steam, than it is possible to attain on the Negative system. Heaters may be applied to abstract a few degrees of heat from exhaust steam and give it to the cold feed-water, but the condensed steam is necessarily lost; and with it the great object in view, *pure water under all circumstances*.

The Differential system, on the contrary, has no cold water to warm, for the feed water, excepting that portion of it which is to make up for the waste (and even that is warmed before entering the heater), is not allowed to become cold at all, but is taken from the main condenser as soon as it has assumed the form of water, and pumped into the heater-condenser at very nearly the boiling point, so that the demand upon that portion of the apparatus is comparatively small. The view which I have taken of the Positive method, may appear to be somewhat at variance with the popular one, which assigns it to a superior economy when working with steam at a high pressure, over the Negative method, but this arises from my having allowed the same pressure to be applicable to both. If, however, high-pressure steam cannot be economically applied on the Negative system, the popular point of view is doubtless the correct one. I have not before alluded to the advantages of using the steam expansively, because that method of working is equally advantageous to all of the three systems. Nor do I think it necessary to do more than allude to the possibility of expanding high-pressure steam until it shall become powerless for all useful effect, for there is a point at which expansion must cease, and that, too, long before it is too feeble to get out of the way of its successor, or has to call upon a vacuum to help it along. I speak of good honest steam, which does its own labour, and then "clears out," without waiting to be dragged out or to be kicked out.

Equations Nos. 7 and 8, speak for themselves: allow that there is a loss by the Negative method of 12 per cent. by condensation in the cylinder with injection, and 18 per cent. with surface condensation, and the former equation shows a gain of 53 per cent. on the one, and 64 per cent. on the other, to which, in the case of sea steamers, we may add 25 per cent. over all, and then we show a gain of 91 per cent. in one case, and in the other 105 per cent. on unquestionable data, without resorting to the undeniable advantage on account of the greatly reduced size of the engine.

In Equation No. 8, for even pure water, such as the lakes have, the gain shown is 60 per cent. over the Negative method, with the like allowance for condensation in the cylinder of the latter, but on the Differential plan, at this pressure, there is none whatever. For the muddy water of the Mississippi, the gain must be fully 100 per cent.

In conclusion, I will remark, that the Negative system with injection, is not economical, on account of its secondary action, and large surface exposed to a great difference of temperature between the two sides of the piston, nor does it admit of the use of its condensed steam, nor the application of heaters to any useful extent. The surface condenser when applied to the same system is still less economical on account of the same defect of secondary action, and still greater difference of temperature to which the cylinder is exposed as well as to the same large surface, and although it does admit of the re-use of its condensed steam (and filth from the cylinder), it is greatly reduced in temperature, which has to be restored in the boiler, but it neither provides for waste supply, nor are heaters of any use.

The positive system is no better than the foregoing. True, it admits of heaters to warm the cold feed-water somewhat, but throws away the very source from which it derives that warmth; a source, too, of entire purity, as well as of great heat, while the medium to which it is transferred is quite cold, and more or less impure, and, so far, unfit for the purpose to which it is applied.

Moreover, the complication of the machinery of the Negative method, together with the large space which it occupies, are most serious objections of themselves, particularly on a steamboat; and the objections to the Negative and the Positive methods, point only to such defects as show the subterfuge nature of both, and the great mistake of the air-pump, which, however valuable in its day, has outlived its need. Such a condenser as the Differential system requires, could not have been made when the air-pump was first introduced, and even now, the chief difficulty encountered has been in the practical details. Per contra, the Differential system has no secondary action to absorb its power, nor has it any large surface or *space* to absorb its heat. It admits of the re-use of its condensed steam, and throws away the filthy part, to use none but the pure, and makes prodigal provision for a supply, not only to make up for the waste occasioned thereby, but also for any other, and on board a steamer for the use of all on board, for any purpose whatever, and with any quantity to spare and at no cost. It provides, also, against lowering the temperature of the condensed steam much below the point at which it assumes the shape of water, for re-heating, even of that much and more, through the medium of heaters, before it again enters the boiler. Therefore, it retains its source of heat intact, after it has left the cylinder, and it retains its purity too, while the impure sloughs away in a soapy state, which would otherwise clog the action of the valves, and line both condenser and boiler with a coat of non-conducting grease. The waste supply is pure also, from whatever source (however impure) it is obtained. The machinery is of the simplest possible character, and occupies the smallest possible space, having in that respect every advantage of the Positive system (with many others), and none of its disadvantages, nor has it any other. In its refuse waste water, it has an advantage too important to be omitted, for, being at a full boiling heat it is available for cooking purposes, as well as for warming the air of houses, manufactories, or ships, for which purposes the waste water on the Negative system of working is quite useless, and the exhaust steam from the Positive one very objectionable.

If the *Differential* system is not the true and *catholic* one, on which to operate the steam-engine for every purpose, whether upon the land or upon the water, in the mine or on the rail, where water is plentiful, and where it is scarce, I must confess to great obliquity of mental vision, and hope soon to be enlightened, not on that subject only, but also on the amount of condensation which takes place in the cylinder, and the loss of power occasioned thereby: I confess my own inability to ascertain either,—mainly, as I believe, because the condensation is many times more in a wet cylinder than it is in a dry one, and its hygrometric state is continually varying. Moreover, I believe that low-pressure steam generally causes the cylinder to be wet, while high-pressure steam, at least when used expansively, causes it to be dry. That expanded steam is dry, I endeavoured to prove some years ago,[12] and although it was a mere deduction,

[12] July, 1847, "Journal of the Franklin Institute" (Third Series), Vol. xviii pp. 134 and 229.

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and as it appeared to me a necessary one from the experiments of others, it has since been proclaimed as an *original* observation of somebody else on the other side of the Atlantic.

If I have thus far rested the claims of the Differential system upon calculations, they are such as challenge the strictest scrutiny, being founded upon facts not liable to error, whether supported by experiments or not. Still, I have not depended upon mere calculations, but have been engaged for years in embodying them, and, at great sacrifice of money and time, have succeeded in doing so.

My experiments have discovered to me the fact that, with steam of about 50 lb. above the atmosphere, cut off at two-thirds of the length of the stroke (stroke 18 inches, piston 8 inches diameter), making 50 strokes per minute for 10 hours per day, the condensation in the cylinder does not amount to two per cent. of the whole steam which passes through it, at least that is all which I could collect from the exhaust pipe before the steam went *up* into the condenser. With higher pressure steam and cutting off sooner, I believe there is no condensation at all in the cylinder after it has become warmed by working some time. I am well acquainted with the value deservedly attached to experiments intended to prove a foregone conclusion, arrived at in perfect good faith it may be, before the invention is put into operation, and then it is wonderful to see the performance "exceed the most sanguine expectations of the inventor." And thus, the supposed fact, instead of causing him to pause as being certainly wrong in his conclusions or in his premises, is extolled as proving the truth instead of the error of his deductions. It is like a "spiritual manifestation," which none but the victims may see. I cannot do better with reference to this sort of delusion, than by telling what happened to a very clever man in England, about 100 years ago.

Mr. Keane Fitzgerald[13] introduced air into the boiler of a steam-engine, by means of a pipe coiled around on the inside of the bottom of it; the pipe was pierced full of holes, and the air was forced into it by means of a pair of bellows worked by the steam-engine itself, and was to rise through the water in *bubbles*, and assist the formation of steam, and on trial was proved to effect a saving of *one-sixth* of the fuel, for it raised one-sixth more steam with the same fuel. The next year, however, like an honest man as he was, he stated that he was entirely deceived, for that "the bellows had never forced any air at all into the boiler, having been split withinside."

What if I should close now? It may be said that I have not shown the universal applicability of the Differential system, by omitting a formula for locomotives. I therefore subjoin one, showing the ordinary or Positive way of working, and allowing (not my allowances, but that of Messrs. Stephenson), 6 lb. above the atmosphere for the back pressure occasioned by the use of the blast.

Lbs. per square inch of pressure above the atmosphere.	Degrees C., of the working steam.	
131	180	Equation No. 9—Positive. $1 = e' = \frac{9{\cdot}929 - 1{\cdot}415}{(661{\cdot}4 - 10),\ \frac{9{\cdot}929}{180 + 272{\cdot}479}}$
211	200	Equation No. 10—Differential. $1{\cdot}25257\ e' = \frac{15{\cdot}380 - 1{\cdot}962}{(667{\cdot}5 - 115),\ \frac{15{\cdot}380}{200 + 272{\cdot}479}}$

The Differential method shows a gain of 25¼ per cent. over the Positive one, partly owing to the use of steam of greater pressure; but that forms part of the system, as will be shown hereafter, for the boiler which renders this pressure far more safe than a much lower pressure is in any other boiler whatever, is not applicable to any other system than the Differential one, although the condenser is applicable to any boiler; the Differential method is, therefore, entitled to the credit of the whole gain of 25¼ per cent. There will, however, be required an additional water-tender to work on the Differential system for the purpose of condensation, and that is all the additional weight required, as the boiler, condenser, and engines, with fuel and water in working order, will be less than on the present plan, and there are two considerations, either of which far outweighs the cost and charge of this addition; the one is the certainty of always having *pure water*, and the other, *a noiseless blast*, for a broken-winded horse of flesh and bone is not, physiologically speaking, one whit more defective than a grunting, snorting, iron one.

The quantity of water required for condensation is calculated at three times as much as the feed-water, of which one-sixth or half as much as the feed-water, is to escape in the shape of steam to the chimney, to answer the purpose of the blast—rather more economically I apprehend, than by forcing it out by the power of the engine.[14]

The back pressure which I have allowed on the Differential system (Equation No. 10), is 14 lb. to the square inch, and if that be not sufficient, any amount that can be required to give greater heat to the upper part of the condenser is easily attainable so as to generate the requisite force of steam for the blast. This point is of considerable importance, and forcibly illustrates the flexibility of the system, the universality of its application having, it is hoped, been established before.

And thus, I launch my *barque* on the ocean of public opinion, asking for it only the favour of an impartial consideration.

[13] 1767, Phil. Trans. (Vol. 1, p. 53); also Farey on the Steam Engine, Note, p. 246.

REGISTER OF NEW PATENTS.

(With Engravings, Plate XX.)

TRANSPULSOR, OR STEERING APPARATUS FOR STEAM SHIPS.

HENRY WYATT, Pall Mall, *Patentee*, October 27, 1855.

By application of a double axis joint in the screw propeller shaft at its point of exit from the ship's stern post, the said shaft, that portion with the screw propeller attached, acting upon the above-named axis joint as a centre, can be turned either to the left or right of the ship's stern, thereby enabling the propeller to drive the ship in any direction with greater facility and rapidity (that is, as regards its steering), than by any plan at present employed. The ship can be turned in less space, as the propeller can be brought to bear direct upon either side of the stern; the rotation of the propeller is not interrupted in any degree during its transit from left to right of the ship's stern, as the double axis joint equalises every deviation of position. The propeller, when not required to act as a rudder, or in aid of the same, can be placed in a central position with the stern of the ship, and with the shaft in continuous line can then act as the present screw propeller to drive her straight ahead. The propeller can be raised into the body of the ship, if required, by a simple detachment in the shaft joint. And is moved upon the same principle as a rudder, and will yield to the blow of a heavy sea.

This invention is particularly applicable to vessels navigating intricate and crowded rivers, and would be of great advantage in case of a vessel running aground.

Claim.—The moving of the screw propeller upon the principal of a rudder, and the application of a double axis joint for the purpose of rotating the same.

[The principle of employing steam power to guide ships as well as to propel them, appears to promise such great advantages that the notion of making that application has often occurred, but no practical plan of the kind has yet been adopted. Paddle-wheels with independent actions have been suggested, and if there were no practical inconvenience attending such an arrangement it would most effectively serve to alter the course of a vessel in the least possible time; and it would, also, possess the advantage of placing the guidance of the ship under the immediate control of the captain, without requiring him, as at present, to shout his commands to the helmsman, with the accompanying risk of misapprehensions and loss of time. The use of propellers placed in the same position as the rudder, still more forcibly

[14] The Messrs. Stephenson admit that the obstruction caused by the blast is 6lb. per square inch on the average, and sometimes "the whole loss of power" they say, "amounts to nearly half that of the engine," and yet, singularly enough, they state further on, that no power is wasted upon working any machinery for the purpose, and it has the advantage of great simplicity in its application." Of course, the power is not wasted, if the labour must be performed, as they assert that it must be by the engine, but may not the blast be taken direct from the boiler? The condenser on the Differential system is, to all intents and purposes, a boiler, and the blast may be taken from that at no cost whatever, for the back pressure is compensated for by the increased temperature of the feed-water. The words last quoted, therefore, do apply most forcibly to the Differential system, but not to the Negative one.

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Hamiltons Girders.

Fig. 1.

Portion of a Girder.

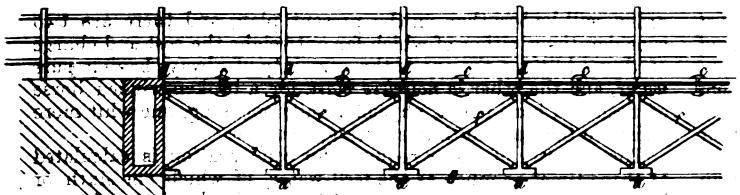
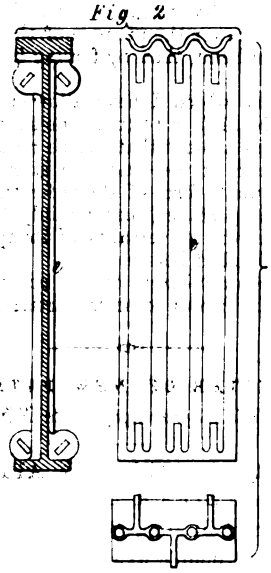
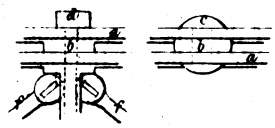
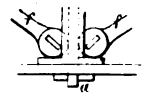


Fig. 2



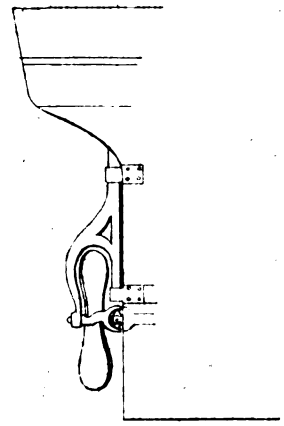


Enlarged Parts of Fig. 1.



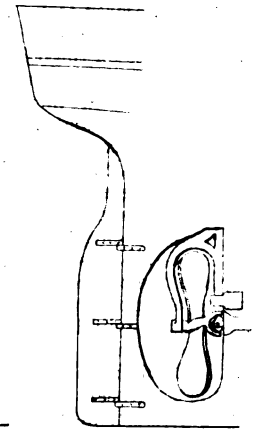
Wyatt's Steering Apparatus.

Fig. 1.



Elevation of Transpulsor to act without a Rudder.

Fig. 2.



To act with a Rudder.

Hamiltons Telegraph Posts.

Fig. 3.

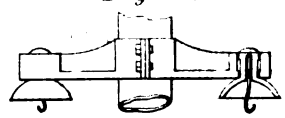
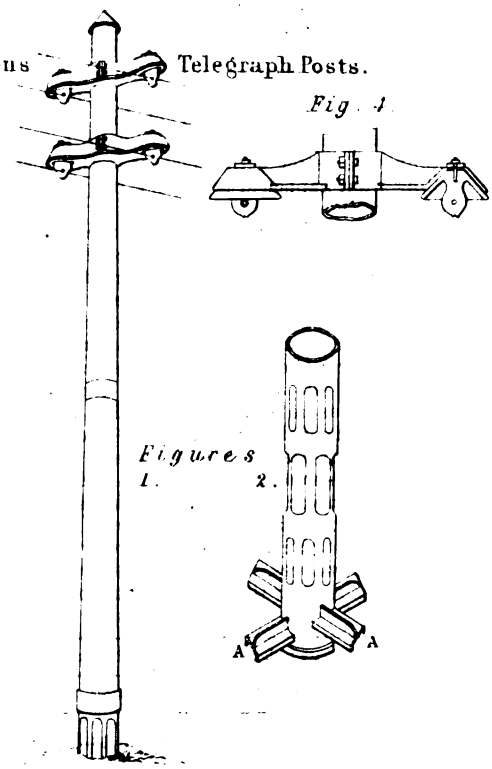


Fig. 4



Knowles & Bellhouses's Working in Marble Stone & Glass.

Fig. 1.

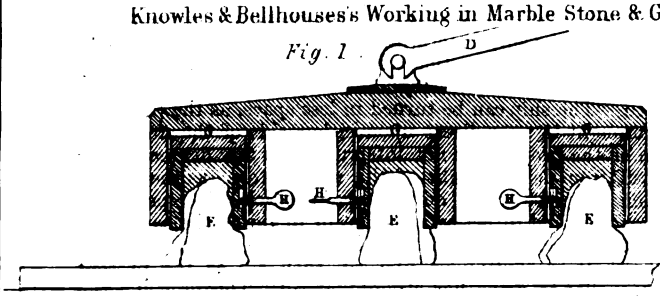


Fig. 2.

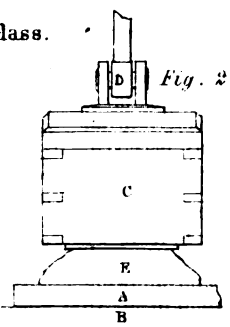
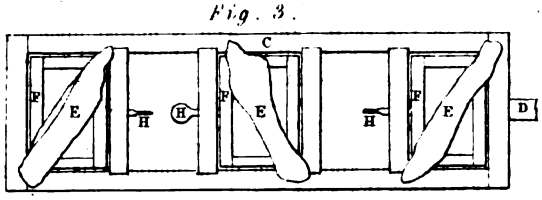


Fig. 3.



Figures 1. 2.

Bessemer's Metal Beams & Girders.

Fig. 1.

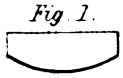


Fig. 2.

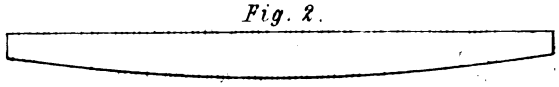


Fig. 16.

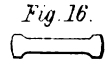


Fig. 17.

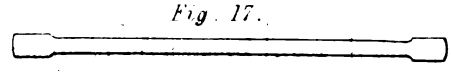


Fig. 3.

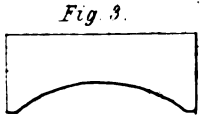


Fig. 4.

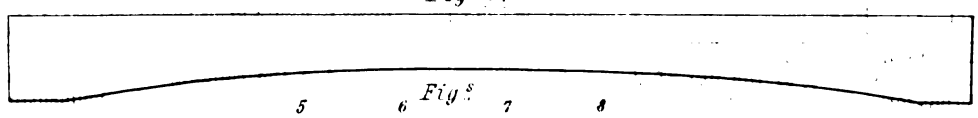


Fig. 15.

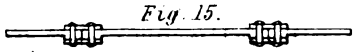


Fig. 5

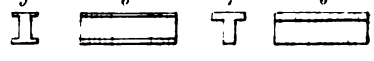


Fig. 12.

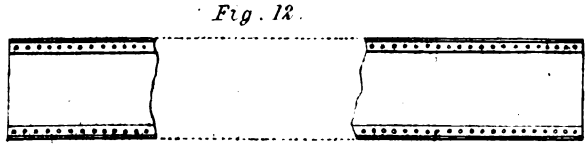


Fig. 13.

Fig. 14.

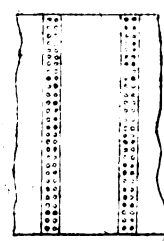
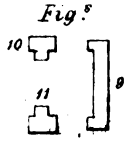


Fig. 8



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seemed to suggest the application of the propulsive power to steering; but it is questionable whether an effective change in the direction of propulsion can be so well attained by giving different inclinations to the propeller, as it would be by varying the motion of independent paddle-wheels. Whatever means are adopted to alter a ship's course they must, indeed, be attended with a loss of motive power; but we think that, independently of mechanical difficulty in the arrangement, the loss would be much greater by the plan proposed by Mr. Wyatt than by the resistance of a rudder to the motion of a ship through the water. Whenever the propeller was inclined from the direction of the main shaft, there would be an oblique strain producing much friction, and the communication of rotary motion in such a position would be attended with great loss of mechanical power.]

MANUFACTURE OF RAILWAY BARS.

HENRY BESSEMER, Queen-street-place, *Patentee*, Oct. 17, 1855.

In the process of manufacturing malleable iron rails as at present practised, the small fragments of puddled iron which are collected together to form a puddle ball are more or less oxydised on their exterior surfaces, and are otherwise coated or mixed with scoria and other extraneous matters. In the squeezing or rolling process which follows, a large proportion of these extraneous matters are driven out, but so much of them is often retained as to prevent an equal and perfect union of the surfaces of all the numerous pieces of which the mass of iron is composed. In the operation of rolling a considerable elongation of the metal takes place, and consequently those parts of the iron which are prevented from uniting (by the scoria, oxide, or other matters), are also much elongated, forming what are called flaws or sand cracks, and giving a more or less detached or feebly coherent lamelar texture to those parts of the iron. The rolling of heavy wheels over such a material tends to elongate the upper stratum, which ultimately becomes loosened and detached from the general body of the rail, and which defect is augmented by the soft and malleable condition common to iron that is entirely deprived of its carbon. The object of this invention is to lessen or remove these defects, and to produce as nearly as may be a homogeneous mass of metal, free from the admixture of oxyde, scoria, or other extraneous matters, before referred to, and at the same time to have combined with it as much carbon as will give it a greater degree of hardness and power of resisting the laminating action of the wheels which pass over it, and in which state of combination the metal is commonly termed steel. Although in some cases the quantity of combined carbon may be so reduced, that a metal much softer than ordinary steel will be produced, one of the greatest objects of this invention being the attainment of the greatest amount of solidity and cohesion of all the particles of metal of which the rail is composed, by bringing the metal to a state of fusion, and allowing such fused or fluid metal to run into any suitable mould or cavity capable of holding the fluid metal, and also capable by its size and form of giving to the metal (when consolidated therein) such a configuration as will be suitable for the formation of a rail or railway bar of any desired sectional form.

Refined iron is put into the ordinary puddling furnace, where it is at first heated in the usual way, being raked about until it has thrown off the greater part of its carbon; but care should be taken not to carry the process of decarbonisation too far, about one per cent. of carbon should be retained. A knowledge of the most advantageous point to leave off the puddling operation will be readily acquired in practise, a good test to the workman being the facility with which the metal will fuse in the succeeding operation.

The quantity of carbon left in combination with the iron may, however, be considerably varied, and thus the rails may be rendered peculiarly adapted to the various strains and wear to which they will be subjected when in use; rails over which very heavily loaded goods trains have to pass are made of well-carbonised steel of a hard quality, thus preventing as far as possible their wear and tear; but where a rail is to be used for light passenger traffic, the iron is deprived of nearly all its carbon, forming a metal of a softer quality, nearly resembling soft iron in toughness, and well adapted by reason of this quality to withstand concussions, consequent on the rapid rate at which passenger trains are moved.

The metal having been brought to the desired point of decarbonisation is raked out of the puddling furnace and allowed to cool; these products may be mixed in large quantities to equalise the quality, or it may be drawn into fire-clay crucibles, arranged in furnaces such as are now commonly employed for melting steel; a little charcoal or other carbonaceous matters are to be thrown into the crucibles among the pieces of metal, which will assist in reducing the oxide formed by the previous operation; the fires in the melting furnaces are to be kept up vigorously until the complete fusion of the metal takes place; it is then to be poured in a fluid state into iron ingot moulds, placed vertically or nearly so, with open tops, the shape of the moulds being such as to give the ingot of cast steel more or less the intended form of the rail; the ingot being, however, much more massive, in order that it may afterwards be reduced in thickness and increased in length, by rolling, in a similar manner to that already practised in rolling railway bars formed of malleable iron. The raw ends of the steel bars may be cut off and remelted by mixing them with fresh portions of metal from the puddling furnace.

The ingot moulds used for casting or forming blocks or ingots of metal to be afterwards rolled into railway bars may be made of iron, the mould opening in two halves, which are detached, and which may be held together at the time of casting by screw clamps, or by a ring passed over them; into which a wedge is driven, so as to force the separate parts of the mould in close contact. Before running the metal in them the mould should be smoked, as already practised in preparing moulds for casting ingots of steel; or, if preferred, the ingot or mould may be formed of sand, loam, or any suitable material in which moulds for casting iron or steel have been found convenient.

The combination of such a quantity of carbon with the iron as to constitute steel will greatly increase its power of resisting the laminating action of the engine and carriage wheels, and at the same time add to its stiffness and cohesive strength, as compared with malleable iron rails of the same sectional area.

Some of the details of this invention admit of a considerable variation, producing a difference in the quality and cost of the rails. As before described the puddled iron is made to retain about one per cent. of carbon. Instead of this, in the second modified process, the puddling operation is to be continued until the carbon is dissipated as far as practicable, the iron being reduced to a dry and powdery state, when it is to be raked out of the puddling furnace, and afterwards converted into steel by cementation with powdered charcoal in close vessels, after the manner employed in making blister steel, or by a continuous operation in vertical retorts, or, in lieu of the puddled iron, small pieces of scrap iron may be used alone or mixed with a portion of puddled iron, and then be converted into steel by cementation with charcoal. These matters may be then melted and otherwise treated as before described. In some cases, however, the process of cementation may be carried on advantageously in the melting crucibles, the pieces of scrap or puddled metal being mixed with charcoal or other suitable carbonaceous matters. When this method is employed a very "mild" steel is obtained, containing very little carbon, and partaking the quality of wrought-iron in toughness, and consequently well calculated to withstand the powerful shocks to which rails are sometimes exposed: in any case, the rails after they are rolled should be annealed or allowed to cool slowly, in order that they may retain as much toughness as possible.

The melting of the steel may be effected by means of the kind of furnaces and crucibles already in use for melting steel, but the same may be accomplished in a cheaper and more convenient manner by the use of crucibles of a larger kind than those generally in use, and provided with holes in the lower part of them, for the purpose of tapping out or discharging the metal from them without the removal of the crucibles from the furnace, the particulars of which mode of melting steel may be known by reference to the specification of a patent granted to the patentee for "improvements in the manufacture of cast steel, and mixtures of steel and cast-iron," dated the 18th June, 1855. Partially decarbonised malleable metal suitable for the purposes of this invention may also be obtained in the manner described in a specification of a patent granted to the same, for "improvements in the manufacture of cast steel" of similar date to this one.

Claims.—1. The running (while in a fused or fluid state) decarbonised or partially decarbonised iron into a mould, and thereby obtaining an ingot or mass of iron suitable for and capable of being formed into a rail or railway bar by the process of rolling,

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and the making from such ingots or masses of malleable metal a rail or railway bar.

2. Melting puddled or partially decarbonised puddled iron in crucibles, and then casting the same into ingots, for the purpose of forming rails or railway bars by the process of rolling.

3. The melting and casting cemented puddled iron into ingots, for the purposes of forming rails or railway bars by the process of rolling.

[The claims of the patentee cover only a small part of the processes described in the specification. The formation of a kind of iron better adapted for railway bars than the iron commonly employed, is the object particularly mentioned, but the method of making the rails from the specially prepared iron is alone protected, and the advantages to be gained by that mechanical operation are not stated.]

METAL BEAMS AND GIRDERS.

HENRY BESSEMER, Queen-street-place, *Patentee*, Oct. 17, 1855.

In the construction of metal beams or girders, it is of great importance to render them as light as possible, consistent with their required amount of stiffness and power of resisting fracture; this is especially the case where the weight of the beams or tension rods form of themselves a considerable amount of the load, as in the case of suspension bridges. The object of this invention is to give the required degree of cohesive strength and rigidity to beams, girders, and tension rods with a less weight of metal than heretofore used in beams of equal strength. For the purposes of this invention, refined or pig iron is put into a puddling furnace, and there worked in the usual way, but leaving off the operation of puddling before the whole of the carbonaceous matters are driven off. About one per cent. of carbon should be retained, or as much as by its combination with iron constitutes steel; or the metal may be puddled until the whole of the carbon is driven off, and the powdery iron resulting from this process may be afterwards converted into steel by cementation; or the refined or pig iron may be otherwise decarbonised and reduced to the state of steel; in either of which cases the metal is brought to a complete state of fusion in pots, similar to those used in the melting of steel. When, however, great toughness is desired, it is preferable to use scrap iron, decarbonised iron, or malleable iron put into the pots alone, or mixed with charcoal or other carbonaceous matters. When used alone, the product will be cast malleable iron; but when mixed with carbonaceous matters, a partial cementing of the iron will take place, and a "mild" or soft steel will result, peculiarly well adapted to resist heavy shocks or sudden strains. The metal having been melted, is cast into beams or girders of the desired form in sand or loam moulds or otherwise, which are afterwards annealed; but when beams, girders, or tension bars are required of great length, or are required to be very light in proportion to their dimensions, the fluid metal is cast in iron ingot moulds, and afterwards the ingot of cast metal is rolled out until the ingot is reduced to the desired thickness; the ingots so cast are to be made of such a form as will correspond with the intended plate or bar of rolled metal. When a fish-bellied beam is required, the ingot should be made straight at one edge and curved at the other, but of much less length, and consequently much thicker than the finished plate is to be.

An ingot of metal suitable for rolling into a fish-bellied beam is represented in the engraving, fig. 1. When an ingot of cast malleable metal of this shape is rolled in the direction of its greatest length, it will when sufficiently elongated produce a plate of metal such as is represented at fig. 2; and when a beam or girder is required, having its under side of an arched form, an ingot should be cast of the form represented at fig. 3, which may afterwards be rolled to form the plate represented at fig. 4. Either the fish-bellied plate or the arched plate may be used between wooden beams, or they may be rivetted to other pieces, so as to form a hollow beam or girder of their respective forms.

When beams or girders having a top and bottom flange are required, the ingot is cast of the shape shown in figs. 5 and 6, and afterwards rolled out; and when bars of a T shape are required, an ingot of the form shown in figs. 7 and 8 is made, and which may afterwards be formed by rolling into the ordinary T shaped metal bars. At the edges of the rolled plates where rivetting is required, a raised rib is formed on the ingot at each edge, and in rolling out the ingot grooved rolls are employed so that an extra thickness of metal is formed at each edge to compensate for the weakening of the plate by making the rivet holes therein; and in a similar way long bars are cast and afterwards rolled having a raised angle running along their edges for the purpose of strengthening them.

In the making of hollow beams and girders by rivetting together plates of rolled metal, those parts of the plates where the lines of rivet holes occur are much reduced in strength, whereby a much smaller amount of force will tear or break the metal plate along the line of rivets than would be required to tear asunder the metal at other parts of the plate where no holes occur. In the making of plates of rolled metal for the construction of beams or girders, the plate is made of greater thickness at the edges where the line of rivet holes is to be made; the ingot for this purpose should have two raised parts at its opposite edges, as shown at fig. 9.

At figs. 10 and 11 are shown end elevations of ingots for angle bars, which may be rolled out and used to form a hollow beam, such as represented in figs. 12 and 13, and in which beam the rolled ingots 9, 10, and 11 are combined. For facilitating the making of hollow beams without the use of angle irons, as usually employed, and in every case where the length of the beam, girder, or tension bar admits, it is rolled of the entire length, so as to have no transverse joints, and thus a thinner plate will suffice. The great cohesive force of the rolled steel and the facility the casting process affords of making a large and suitable shaped piece for rolling with angles or webs formed thereon, permits the construction of beams or girders of great strength and rigidity in proportion to their weight, as compared with iron beams of the usual form. But when beams or girders of very large size are required, so that several plates must be combined, the thick edges of the plate are placed so as to form the vertical joints, as represented at fig. 14, which is a side elevation of a portion of a beam so constructed; a horizontal section of which (on a larger scale) is shown at fig. 15, where the plates are shown as secured with butt joints, having a plate on both sides. Tension bars with enlarged ends may also be formed by rolling, provided the ends of the ingots are enlarged in the required proportions; an example of this is shown at fig. 16, which represents the ingot, which may afterwards be rolled into the form shown at fig. 17.

Claims.—1. The casting or founding in malleable iron and steel, beams, girders, and tension rods used in the construction of roofs, floors, and other parts of buildings, and in the construction of viaducts and suspension and other bridges.

2. The rolling of ingots or masses of cast malleable iron, also ingots or masses of cast-iron containing more carbon than ordinary bar or plate iron, but a less quantity than is found in steel; also ingots or masses of cast steel or of iron containing as much carbon as ordinary cast steel, and forming thereby, or by the junction of one or more pieces so produced, beams, girders, and tension bars suitable for the construction of roofs, floors, and other parts of buildings, and for the construction of viaducts and suspension and other bridges.

3. Forming an extra thickness at the edges of cast ingots of malleable iron and steel, in the manner and for the purposes herein described.

[This invention so closely resembles the preceding one for making railway bars, that they might both have been included in the same patent. The principle of the invention is, however, more fully developed in this specification. The previously prepared metal, which is intermediate between steel and wrought-iron, being cast into ingots of the general form that the girders are intended to be when rolled, it is assumed that by the process of rolling they will be elongated exactly to the shape required, without undergoing lateral expansion. How this is to be effected the specification does not state, nor is there any description of the mechanism by which the beams with flanges and other forms are to be rolled. Taking for granted that the beams can be so made, and that the practical difficulty of rolling the flanges as well as the sides of the beam can be overcome, there is little doubt that beams so manufactured would combine strength and lightness in a great degree.]

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STEAM BOILERS AND FURNACES.

SIMON O'REGAN, Liverpool, *Patentee*, October 27, 1855.

THE improvements refer, firstly, to arrangements peculiarly adapted for fine boilers, and particularly that description used for marine purposes, the object being to promote the circulation of the water, to diminish the amount of scale deposit, and to facilitate its removal; and, secondly, to improved construction in furnaces, with the view to promote combustion and prevent the ormation of smoke.

Marine boilers constructed according to these improvements require the main flue spaces to be of sufficient dimensions to contain in one arrangement adopted, tubes placed either vertically or slightly inclined instead of horizontally, as usually practised. The spaces between the tubes and the diameter of the tubes may vary according to circumstances, but their length will depend on the space between the top of the furnace and the top of the crown of the boiler, and the hot air and products of combustion from the furnace will pass off upwards through or around these tubes, and so onwards to the chimney or funnel. By these arrangements the greater part of the usual deposits of the water will fall into the large portions of the boiler used for marine and other purposes, and incrustation in or around the tubes will be considerably diminished; and tubes so arranged, and secured by rivetting or otherwise, are also further advantageous, in consequence of their being easily scaled or cleaned. At the take-up or back end of the furnace the heated air and products of combustion pass through the tubes when they are placed vertical, but around the outside of the tubes when they are placed inclined and used as water tubes, and also around such vertical tubes as are placed in the flues. Or alternate narrow flues and water spaces are arranged, formed with plain or galvanised corrugated metal boiler plates, in the main flues and shell.

In furnaces adapted to these improved arrangements of boilers, behind the fire bridge an air chamber is constructed, having a perforated or slotted metal plate or one of other suitable material with which to box it in, and thereby promote the admixture of the air and gases to favour ignition, the said air box receiving air through slots, and a port covered by a regulating valve. In furnaces closed at the front and fired from a side door, a hot-air channel or chambers is fixed in the front brickwork, similar to the plan for furnace doors, admitting the air at the lower part outside, and discharging it at the top inside the furnace through slots or perforations, and in like manner admitting air in front and through the brickwork, when required; and in all cases it is recommended to combine therewith the hollow bridge, perforated air box, and valve, before named. The furnace bars have a chilled surface, and are made moveable by a joggle shaft. The dead plate is usually in one solid piece; but it is preferable to use one cast with slots or perforations, or in bars laid at right angles to the furnace fire bars, and kept apart by side nibs. Between the furnace door frame and dead plate is placed a bar with thickness pieces to admit air, and which when removed allow the dead plate to be shifted. The furnace door is likewise arranged to admit a regulated quantity of air to the furnace through its box or chamber attached thereto on the inside of the door, perforated or slotted, as before named, and sometimes with ribs cast on such air box; and for wide furnaces air boxes are also fixed on each side of the door frame.

Claims.—1. The peculiar arrangement of tubular or flue marine and other boilers.

2. The modes of constructing furnaces in connection therewith.

[This specification is unaccompanied by drawings, and the proposed arrangements are not indicated in a manner sufficiently precise to convey an exact idea of their construction. The plan of vertical tubes would in a great measure defeat the object of tubular boilers, as the heating surface would be too short to obtain the full effect of the heat; unless, indeed, there was an accompanying contrivance for directing the draught up and down alternate sets of tubes, of which there is no indication in the specification. Vertical tubular boilers are indeed no novelties, for the boilers of Col. Maceroni's steam carriage were constructed in that fashion twenty years ago, but in those days the advantage of long-bodied boilers was not appreciated. With regard to the advantage expected to be derived from vertical tubes as preventives of incrustation, we consider it to be very questionable. The incrustation on the tubes does not arise from sediment, which would be prevented by the ebullition; but it is caused by the act of vaporisation, the particles of salt dissolved in the water being deposited or attached to the heated surface at the instant of separation. The contrivances for effecting a more perfect combustion of fuel by special admission of air to the furnace, and by the form of the fire bars, are so vaguely described as to give no idea whether they are different from the many other similar contrivances that have been invented.]

MANUFACTURE OF IRON.

WILLIAM TAYLOR, Haughton, Salop, *Patentee*, November 1, 1855.

This invention consists in treating iron by the method hereinafter particularly described, at that stage of its manufacture in which cast-iron is converted into wrought-iron. The cast-iron is introduced into the puddling furnace, and melted and puddled until it acquires a semi-fluid or pasty consistence. The iron when in the state last described is discharged from the puddling furnace into a vessel or reservoir of water. The discharge of the iron into the water may be conveniently effected through a door in the back of the furnace. By the treatment described the iron is cooled in the shape of a spongy mass, the water at the same time cooling the iron, and preventing its oxidation by the air during the said cooling. The iron after removal from the water is reduced to a granular powder by being passed through rolls, by being ground in a grinding mill, or by stamping. The granular powder is separated into portions of different degrees of fineness by sifting; the several powders are then washed, and each portion is separately treated in a furnace. In the last-named furnace the iron is balled in balls of sizes suitable to the purposes to which the iron is to be applied. The several powders into which the powdered iron has been separated by sifting produce iron of different qualities, the finest powdor producing the best. The balls are hammered into blooms or other forms in the ordinary way, and afterwards rolled into the various sizes by the ordinary rolling process.

Claim.—Improvements in the manufacture of iron, whereby iron of better quality can be made from the same cast iron than by the ordinary process; that is to say, cooling the partially puddled iron by immersing it in water, and afterwards reducing to powder the said iron before subjecting it to the balling process

[The advantage of such a process of manufacturing iron can only be tested by practical working. The reduction of the cast-iron into a fine powder before being remelted would, we conceive, tend to improve the quality, by exposing a vastly enlarged surface to the action of heat, and by this means equalising the structure of the metal. The notion which the patentee entertains that, by pouring the melted metal into water he shall prevent its oxidation during cooling, is directly opposed to the known action of hot iron on water. So far from excluding the iron from oxygen, the pouring of it into water is plunging it into a bath of liquid oxygen, which immediately combines with it.]

CONSTRUCTION OF IRON GIRDERS.

JOHN HAMILTON, jun., Liverpool, *Patentee*, May 4, 1855.

This invention has for its object improvements in the construction of iron girders when using corrugated iron. For this purpose, in constructing a girder, sheets of corrugated iron (galvanised or not) are to be fastened together by rivetting or screw-bolting to the extent of the length and width of the intended girder. One, two, or more such series of corrugated sheets of iron may be used in constructing the upper part of a girder; and where two or more series of corrugated sheets are used, they are to be fastened together, and kept at a distance apart and parallel to each other by transverse partitions of wood, or of cast or wrought iron, with undulations to correspond with and fit the corrugations of the corrugated sheets; and where the distance apart of two sets of parallel sheets of corrugated sheet iron is considerable, vertical partitions of corrugated sheet iron are used. Such partitions may be affixed by means of corrugated angle iron to the horizontal plates of corrugated sheet iron; and such vertical transverse partitions of corrugated sheet iron are also used as upright props when combining the upper part of a girder with the lower part of a girder, whether such lower part consists of corrugated sheets of iron or plain sheets of iron, and in addi-

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tion to such vertical partitions or props of corrugated sheet iron, diagonal sheets of sheet iron, either wrought or cast, and either corrugated or plain, are used.

Fig. 1 shows a side view of part of a girder constructed according to this invention; *a*, *a*, are two corrugated plates of iron, which are kept apart or at a distance from each other; *b*, *b*, are transverse uprights or supports of cast-iron or other suitable material, corrugated on their under and upper surfaces, to correspond with the corrugations of the sheets or plates of iron *a*, *a*, which sheets or plates of iron *a*, *a*, are rivetted together at their edges and ends; *c*, is one of several screw bolts, or it may be a rivet, which connect the plates or sheets to the upright *b*, and to each other; *d*, *d*, are other screw bolts, or these bolts may be made with heads at one end, and suitable for receiving keys or cotters at the other end. These bolts *d*, pass through the plates *a*, *a*, through the uprights or separating pieces *b*, *b*, through the cast-iron uprights *e*, *e*, which are formed, as is shown at fig. 2, with tubular ribs, through which the bolts *d* pass; and these uprights *e* are also formed with lugs or projections to receive and have keyed to them the tie rods *f*, *f*, and the upper ends of these uprights *e* are made with corrugations, and such is the case in respect to the lower ends thereof when the second or lower series of plates *g*, *g*, are made corrugated, or they are made with plain ends or feet when the plates or sheets of iron *g*, *g*, are plain and not corrugated. Only two plates *a*, *a*, at top, and one thickness of plate *g* are shown at the lower part of the girder, this may be varied according to the strength desired to be given to the girder; where considerable strength of girder is required, and it is desired to use comparatively light sheets of iron, two or more corrugated sheets are placed in contact, as if they were one plate in thickness, and used in other respects in forming a girder, as before explained.

Claim.—The combination as herein described of corrugated plates or sheets with other parts, as explained, to keep them at a distance in order to form girders.

[The mode of arranging and fixing the corrugated sheets of iron are not clearly described in the specification, which should have been illustrated by cross sections. So far as we understand the plan, two or more corrugated sheets of iron are to be placed parallel to each other, but kept apart by blocks of wood two or three inches thick, so that the upper surface of the girder would consist of a thickness of two or more sheets of corrugated iron with intermediate spaces; the different sheets of iron being bound together by screw bolts. This plan would combine strength and lightness, but in a long girder required to support great weight, the chief reliance would be on the cross stays which bind the upper and lower series of plates together, and serve to distribute the pressure over a large surface. If the drawings in the specification are to be taken as correct representations of the proportions recommended, the junctions of the stays to the bolts are too weak to bear the strain.]

ELECTRIC TELEGRAPH POSTS.

JOHN HAMILTON, jun., Liverpool, *Patentee*, January 16, 1856.

This invention relates to the posts or uprights employed in constructing electric telegraphs, for which purpose each post or upright is constructed as follows:—A cast-iron plate or foot is formed with an upright tubular socket; such socket is at its lower parts made with openings, so that the earth may fall through and fill in the interior of such socket. The upper part of the post or upright is made of a tube of wrought-iron, by preference coated with zinc, and its lower end enters the socket, and is fixed thereto by rivets, or otherwise. The socket rises to some inches above the earth. The top of the post is covered in with a cap, to throw off the rain from the post, and a transverse bar or bars of wood fixed to the upper part of the post or upright to receive the wires.

Fig. 1 shows an electric telegraph post, constructed of tubular wrought-iron, and fixed according to this invention. Fig. 2 shows the lower portion of the post, which is formed with holes through it, in order that the earth may fall through and aid in the fixing of the post and parts. In fig. 2 it will be seen that the foot is made, by the passage of the parts A, A, through the lower part of the tubular post, to form the feet; or in place of such parts A, A, a cast-iron plate or foot may be formed in a suitable manner for having the tubular perforated post fixed thereto; or, if preferred, such foot may be cast with a tubular socket, suitable for receiving and having fixed thereto the tubular post; or the foot may be cast so as to receive the hollow upright thereon, and so that it may be fixed by a hoop, or otherwise. The arms for suspending the telegraph wires may be of wood, and fixed in any suitable manner; the engraving shows the arms of metal, such as have been lately invented. Figs. 3 and 4, show arms of metal suitable for being fixed to the upper part of the post, as is shown at fig. 1; but instead of such arms, others of wood may be used, Iron arms are preferred, particularly those shown at fig. 4, as the ends of the metal arms form metal caps for covering the glass or earthenware insulating instruments.

Claim.—The manufacture of electric telegraph wrought-iron tubular posts, as before described.

[The plan hitherto adopted in supporting telegraph wires, has been to suspend them from wooden arms attached to wooden posts, with the view of attaining more perfect insulation by the employment of non-conducting supports. In some of the earlier plans, indeed, special arrangements were made to insulate the supporting arms more completely from the posts. To employ metal posts and metal arms would at that time have been considered ridiculously ignorant of the requirements of telegraphic insulation. The fact, however, that the hundredth part of an inch is sufficient to insulate the wires of the magnetic coils, might have shown the uselessness of the precautions about the wooden posts, which are moreover rendered of no avail during rain or fog. The attainment of a short space of good insulation is far better than a large imperfect insulating surface. It is on this principle that Mr. Hamilton's system of suspending telegraphic wires is based. The main point for consideration in this, as in all other cases, is the comparative economy (considering durability) of wood and iron. The great care taken to insulate the wires at the suspension posts, we have long considered to be in a great degree unnecessary, and Mr. Hamilton's plan is calculated to dispel the notion that the loss of electricity in a long circuit takes place by escape along the posts to the ground.]

MACHINERY FOR WORKING IN MARBLE, STONE, AND GLASS.

JOHN KNOWLES and EDWARD TAYLOR BELLHOUSE, Manchester, *Patentees*, May 16, 1855.

This invention relates to certain constructions and arrangements of machinery or apparatus for effecting the intermediate processes in the working of marble, stone, glass, &c., which occur between the grinding or sanding and the polishing or finishing processes, such intermediate processes having hitherto been effected by manual labour only.

According to the present invention, the stones or other substances employed in preparing or smoothing the surfaces of marble, stone, or glass, are cemented diagonally into wooden or metal boxes; and two, three, or more of these boxes, each containing a stone, are fitted loosely inside suitable compartments in a larger or main box or carrier. At the top of each compartment of the main box or carrier is fitted a piece of vulcanised india-rubber or other elastic material, such material being thus interposed between the top of the main box and that of the smaller or loose box containing the rubbing stone. The marble, stone, or glass to be smoothed or prepared is fastened to a traversing bed or table, and the box or carrier containing the rubbing stones or other smoothing materials is moved backward and forwards along the surface to be smoothed by means of a suitable driving rod. As the boxes which contain the stones are smaller than the compartments of the main box or carrier, an alternate oblique motion will be imparted to the rubbing stones during the backward and forward traverse of the carrier. As the work proceeds, stones or other materials of various degrees of fineness are used. The loose boxes are prevented from falling out of their compartments when the main box or carrier is elevated by small screws for that purpose.

Fig. 1 represents a longitudinal section of the main box or carrier with the rubbing stones contained therein; fig. 2 is an end elevation of the same, and fig. 3 is a plan of the under side of the apparatus, corresponding to fig. 1. The marble or other material A, to be operated upon is laid or fixed upon the traversing table B, and the block C is traversed backwards and forwards by the driving rod D, actuated either by hand or by any suitable driving mechanism. The stones or other smoothing materials E, E, E, are connected obliquely into the small boxes F, F, F, which boxes fit loosely into the compartments of the main block

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C, by which means an alternating oblique motion is imparted to the stones E, E, E, and to their containing boxes F, F, F. In the compartments of the main block G, G, G, are pieces of vulcanised india-rubber or other suitable elastic material, interposed between the tops of the boxes F and the under side of the back of the main block C, for the purpose of deadening the shock at the commencement of a stroke, as well as to impart a general easy and yielding movement to the smoothing stones E, E, E. A set of thumb screws H, H, H, are fitted in the divisions of the compartments in the main block C, and enter the sides of the boxes F, for the purpose of preventing such boxes containing the stones E, from dropping out when the main block C is lifted off the marble or other material to be smoothed.

The patentees do not confine themselves to the precise details or arrangements described, as many variations may be made therefrom without deviating from the principles or main features of the invention.

Claims.—1. The general arrangement and construction of machines or apparatus as above described for the purpose of effecting the intermediate processes in the working of marble, stone, glass, and similar materials.

2. The construction and arrangement of blocks for smoothing marble or other similar materials, wherein such blocks are composed of a number of smaller boxes working freely therein, and containing the necessary smoothing stones, as herein-before described.

3. The application and use of any suitable elastic medium interposed between the boxes containing the smoothing stones and the main carrying block, for the purposes herein-before referred to.

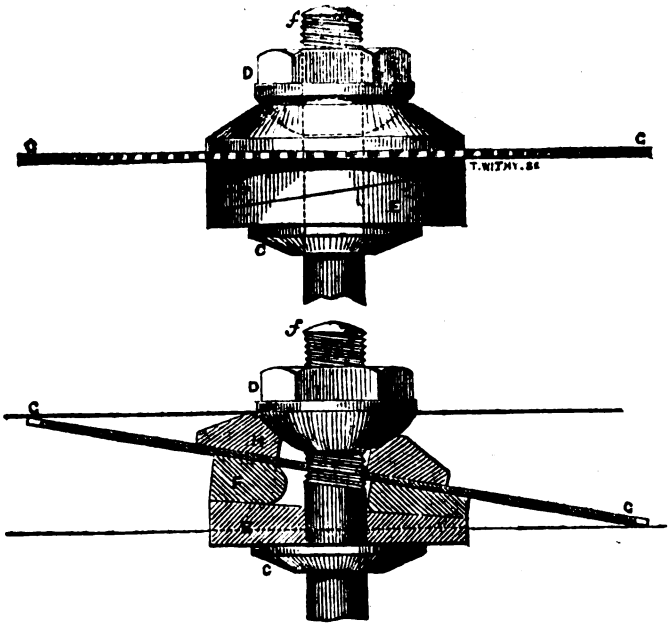
[There is scarcely any manufacturing operation that seems so rude, and which more requires the adaptation of improved mechanical appliances, than the surface grinding of marble and glass. The slow and laborious process of moving either one piece of marble on another, or pushing backwards and forwards one sheet of glass on the face of another sheet of glass, without any mechanical appliance, seems a wearisome application of manual strength; and this operation appears the more rude when contrasted with the admirably contrived mechanism to be seen in the same manufactory for polishing the surfaces so laboriously prepared for that finishing. Mr. Knowles's invention professes to supply this want in manufacturing industry, but it does so very imperfectly. It prepares a superior kind of polishing implement, but it leaves it to be worked slowly by manual labour as at present. The diagonal position of the working stones is a decided advantage in facilitating the action of the smoothing surfaces, but such an arrangement would require special and more careful dexterity in the workman to prevent inequalities. The same difficulty would apply to the oblique position given to the stones by their being fixed in moveable boxes. So far indeed is this invention from tending to bring the operation of marble smoothing within the domain of mechanical agency, that it seems to render manual skill more than ever indispensable to prevent the peculiar action of the smoothing implement from producing ridges on the surface.]

FIRE-PROOF MATERIAL FOR FURNACES.

Mr. David Hill, of Tipton, Staffordshire, forge-manager, has patented an invention for "preparing a material capable of resisting fire, and especially suitable for the interior of puddling and other furnaces." The inventor employs materials that have been subjected to the greatest heat that furnaces excite. The material consists of limestone and ironstone, or the cinder from furnaces, which are melted together and cast into moulds. The proportions preferred are: one-sixth part of limestone and two-third parts of ironstone or cinder; these are mixed together and fused. Experience has taught that the vitrified slag of the furnace is well adapted to resist the heat by which it has been melted, the vitreous covering of the bricks protecting them from the further action of fire.

If a compound of gypsum and sulphate of magnesia be used on the floor of stables it will absorb the moisture and ammonia, keep the stable dry, and free it from offensive smell. The compound salt, after it has absorbed all the moisture possible, is removed to be used for manure, and fresh salts applied in the same way. This is an excellent plan for keeping stables dry and healthy.

HIGHFIELD AND HARRISON'S PATENT ADJUSTABLE CIRCULAR SAW.



This invention consists in securing a circular saw to its spindle in an oblique direction, so as to make a saw of the common construction to cut grooves or rebates of any required widths. This is effected in the following manner.

Between the saw G, G, and collar C, on the spindle, are two bevilled washers E, F, each capable of being turned round independently of the other; and on the opposite side is a plain washer H, having a concave recess for receiving a convex nut D, which screws on to the end of the spindle, and secures the saw firmly thereto. The whole is so arranged that by changing the relative positions of the two bevilled washers E and F, a surface more or less oblique with the axis of the spindle is presented for the saw to be screwed against. Thus the obliquity of the saw with the axis of the spindle may be varied at pleasure, and grooves or rebates of various widths cut into the wood submitted to its action.

This is a most ingenious contrivance, and will save the great expense of having saws made to the thickness of the rebate required.

The invention has been patented by Mr. Henry Laxton, as a communication from Messrs. Highfield and Harrison, of the United States.

On the 17th of June, an architectural meeting was held at St. Alban's, partly as a spot convenient and suitable for such a purpose, and partly to explain and further the objects contemplated in connection with the abbey alterations, to which we called attention in our May number. The early trains brought visitors from a distance, including members of the Middlesex Archæological, and Northamptonshire and Worcestershire Architectural Societies, who perambulated, under the guidance of Mr. Lowe, the sturdy walls of ancient Verulam, in many places perfectly defined; also investigating the Roman remains of a theatre near the venerable church of St. Michael, visited as the burial-place of Lord Bacon. In the afternoon, a "peripatetic" lecture was delivered in the abbey church, by Mr. G. G. Scott, the appointed architect, who conducted his audience through the various portions of the edifice, pointing out the origin and history of each, a proceeding of which the interest was enhanced by his exhibiting several plans and views of its conjectural restoration at different periods. Subsequently, a paper was read in the Town Hall, by the Rev. G. Ayliffe Poole, on some applications of "colour in architecture," which, with the distribution of prizes in the school, constituted the chief events of the day. The weather being favourable, the company numerous, and creature comforts not wanting, the day was passed in a very agreeable and profitable manner.

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THE PROPOSED NEW SITES FOR THE PUBLIC OFFICES.

The Committee on Public Offices have had several sittings, and have agreed upon their Report. This committee will advise the House of Commons to sanction the purchase of the entire block of buildings from Richmond-terrace, on the south side of Parliament-street, to the Thames and the Houses of Parliament. They will advise the purchase of the whole of the buildings between the north side of Parliament-street and the park, and from Downing-street to the Broad Sanctuary, Westminster. When once this extensive area is obtained, the government will be in a position to erect as it were under one roof all the principal offices of the state; the Houses of Parliament will then stand out effectively in all their beauty. There will be a continuation of the street from the Horse Guards to the Abbey at a similar width to what it is at present between the Treasury and Gwydyr House. The Abbey will also be thrown open to view, instead of being shut in, as it now is, with unsightly buildings; and it is probable, when these alterations are effected, that the block of buildings facing the House of Lords, and hiding the western portion of the Abbey, will also be pulled down. From the new bridge at Westminster there will be a wide road, terminating at Richmond-terrace, where it will join Parliament-street, and eventually, it is not improbable that there will be a road from Waterloo-place across the park to some point between Storey's-gate and Downing-street, which will run direct to the Houses of Parliament. The expense of all these improvements will, doubtless, be very great, but it is proposed to throw the expenditure over a long series of years, so that the outlay will not be materially felt. In order to guard against extravagant expenditure, as in the case of the Houses of Parliament, where already the outlay is more than three times the amount of the estimate, and the buildings not yet completed, it will be proposed, instead of handing over the erection of these buildings to different commissions and committees, as in the case of the Houses of Parliament, to place the management of the work entirely in the hands of the Chief Commissioner of Works, and to hold him responsible for the expenditure of every shilling. By the adoption of this course it is confidently anticipated that a recurrence of the case of the Houses of Parliament will effectually be prevented. It is also intended, if possible, to have these new buildings erected in a manner unsurpassed in Europe, and to this end it has been deemed advisable not merely to throw the plans open to competition amongst the English architects, but to the architects of the whole world. Prizes will be offered for the best design, and all those competing will, if their designs are anything up to the mark, be reasonably remunerated for them, the plans to become the property of the Government.

THE EMBANKMENT OF THE THAMES.

The question of the embankment of the Thames has been taken up by the Metropolitan Board of Works, and a motion has been made for a committee of the board to consult with the government as to the best means of carrying it out, as well as to ascertain how far the government will assist the board in the shape of funds, &c. Next to the main drainage of the metropolis, the board could not entertain a more popular question. For the last fifty years the subject has been frequently broached in Parliament, but as yet the legislature have hesitated to devote the public money to what, to a certain extent, they consider local improvements. But there were evidences of the feeling of the public having undergone a great change. More enlarged views are beginning to be broached, and country members are to be found who consider that the metropolis ought to be improved as much as possible, as the seat of the legislature, and the centre to which the inhabitants of the country continually flock. There are, therefore, hopes that ere long the government will seriously turn their attention to those projects for the improvement of the metropolis that may be brought before the country. Hitherto there has been no central body to devise and carry out improvements irrespective of the government; but now the Metropolitan Board of Works is in a position to take the initiative, and if they only show a resolution to carry out great works, such as the embankment of the Thames, they will not lack the support of the government and the House of Commons, and the ratepayers. Plans from time to time have been suggested for improving the banks of the Thames, but from the want of funds and other causes they have, one after the other, been laid aside. The best plan, perhaps, was that put forward by a company in 1845, with the Earl of Devon as its chairman; this proposition was to embank the Thames from Westminster-bridge to London-bridge, to have a wide esplanade and quays and a railway. Their calculations, founded on the increased value of the property, show the prospect of a fair dividend, without having recourse to parliamentary aid. The plan at the time was well received, but the company was brought out too late; the panic of 1846-7 ensued, and swamped, with other projects, the Thames Embankment and Railway Company. Since then, however, the subject has been investigated by a committee of the House of Commons, and they unanimously recommended that the work should be undertaken either at the expense of the government or by private enterprise. A company has since been formed, and their plans are now under the consideration of the Committee of Works and Buildings of the Metropolitan Board of Works.

The advantage both to the navigation and to property on the banks of the Thames by an embankment can scarcely be overrated. At present, the bed of the river, from the erection of so many bridges and from other causes has become so bad that at low-water, with a westerly wind, it is with difficulty that even the light steamers plying above London-bridge can navigate it. Were the Thames properly embanked, not only would this inconvenience be removed, but crafts and barges could load and discharge cargoes at all times of the tide. This, however, is but one advantage. The main sewage of the metropolis is to be diverted in three years and a half from its waters. There will then only remain its mud-banks, and if the proposed plans for embanking the Thames are carried into effect, then the quays on each side of the river will afford the means of health to tens of thousands of the metropolitan population. As to the advantage of embankment, the small portion that has been effected by her Majesty's Board of Works, at Millbank, sufficiently proves this, and when it is extended to London-bridge, it will afford one of the most splendid esplanades in the world. The cost, doubtless, will be very great in the first instance, but eventually there is little question that the improvement will be more than self-paying. The value of river frontage, great as it is, will be enhanced nearly tenfold, as at the same time the wharfage area will be largely increased, and there will also be erected a series of splendid shops and hotels. Besides these advantages, however, the cost of the main drainage north of the Thames would be materially diminished. According to the present plan for the low-level sewer, should the Thames not be embanked, a large amount of valuable property will be seriously injured and endangered by the formation of the high sewer, which is to run along and under some of the principal thoroughfares from Chelsea to London-bridge. On all points, therefore, the embankment of the Thames ought to find favour with the Metropolitan Board of Works.

Many of the most influential members of the board have already pronounced in its favour, and their engineer, in whom the board appear to have every confidence, puts forward the embankment of the Thames as a very important adjunct to his plan for the sewage of the metropolis.

NOTES OF THE MONTH.

A meeting of the Archæological Institute of Great Britain and Ireland will be held in Edinburgh, in the week from the 22nd to the 29th instant.

There are three distinct projects for a new National Gallery, and a fourth, not so well defined. The first is that of removing the collection to Kensington Palace. The second is for fixing it in the space between the Kensington-road and Brompton. The third is for pulling down the present structure in Trafalgar-square, and for building on the site a National Gallery worthy of the position and of the English name. Under the fourth head are comprised the various suggestions which have been offered from time to time for fresh sites at different points at the West-end. The most promising of these is perhaps the southern side of Pall-mall, or rather that portion of it which lies between the Carlton Club and St. James's Palace. This is all Crown property, and a considerable section of it is actually occupied by the Ordnance Office, the business of which will shortly be transferred to Whitehall.

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Mr. Burford's Panorama, Leicester-square, is now exhibiting the fall and interior of Sebastopol, from the Malakhoff, and the assault on it and the Redan. Although the actual incidents of the late Russian war are now, happily, matters of history, it will be long ere the interest which its actions and scenes have elicited dies away. To those who would view the contest from afar, and realise as truthfully as may be some of its terrible issues, perhaps no better idea can be conveyed than by such vivid representations as Mr. Burford has put forward. To say that as works of art they are among the best of their kind, will be understood as conveying an opinion of their no mean excellence, while, as no doubt faithful portrayals of what they profess, they are invested with a lingering attraction far beyond the influence of ordinary pictorial delineations. Another addition has just been made, equally well-timed, viz., a panorama of St. Petersburg.

The extensive works in progress at the Surrey Zoological Gardens are approaching completion, under the energetic management of Mr. Tyler. Although the interior of the enormous new music hall is at present filled with scaffolding, it is confidently expected that the whole will be cleared out within ten days and the place made ready for occupation, together with the large refreshment-room immediately adjoining. This hall is 172 feet long, 100 feet wide, 77 feet from the floor to the crowning arch of the roof, and 96 feet to the top of the towers. The grounds have been much improved, and are now having their finishing arrangements bestowed upon them from the hands of the landscape gardeners. Mr. Danson, the eminent artist, and his son are also proceeding with their magnificent view of Constantinople. Mr. Danson has already completed his wonderful fairy grottoes and caverns.

Messrs. Nelson and Innes, of Whitehall, are urging on their contractor, Mr. Myers, who is pursuing the works with great perseverance, at the Junior United Service Club-house, and will soon have the whole completed. This edifice has a very large amount of stone carving bestowed upon its exterior, and the interior is being embellished in the most superb style. The ceilings of the principal apartments are covered with panellings and stucco-work in bold relief. The entrance-hall and staircase, when finished, will be very magnificent; the former is being lined with stone of extremely fine texture, and the staircase is elaborately decorated in plaster-work.

At Nutfield, Surrey, H. E. Gurney, Esq., of Lombard-street, is making extensive alterations and additions to his mansion, from the designs of Mr. Edwin G. Pennington, of Newman-street. The house is situated on a plateau commanding very extended views of the surrounding country. At the distance of about 20 yards from the back wall, a mass of solid rock-work rises nearly perpendicular, crowned by a wood of old standing. The ground in front descends very abruptly, and is thickly studded with venerable oak trees. The main building, with the offices, coach-house, and stables beyond, have a total length of 159 feet, facing the south. The depth of the principal block of the structure is 43 feet, and its height to the top of the parapet 32 feet. The parapets have copings of moulded brickwork, and the stringcourses, jambs of the doors and windows are worked in the same material. On the ground-floor are arranged the breakfast, dining, and drawing rooms; on the first-floor are seven bed rooms, dressing and bath room, with hot and cold water laid on; the second-floor contains six bed rooms, with linen-closet and other conveniences. The principal rooms are decorated with great taste and in the most *recherche* manner. The entrance-hall is 38 feet long and 14 feet 6 inches wide, fitted up in the most characteristic style and paved with encaustic tiles. The contractors for the works are Messrs. Burnet and Russell, of Nutfield.

The first stone of a new church was recently laid at Kilburn, in the parish of Hampstead. The church will consist of nave, aisles, transepts, chancel, and chancel aisles, with a tower and lofty-broach spire at the south-west angle. It is to accommodate 1160 persons. The style of the building is in the flowing Middle Pointed. The cost will be 8000*l*. The architects are Messrs. Francis; and the builders, Messrs. Holland, of Duke-street, Bloomsbury.

Messrs. Weightmans, Hadfield, and Goldie, of Sheffield, architects, have just prepared plans of a new Roman Catholic Church to be erected at Scarborough; the plans are open to the inspection of persons wishing to contract for the works. The church will be in the Early English style, and will be capable of holding nearly 2000 persons.

The foundation stone of a new church was laid recently at Broughton, near Pershore. The architect is Mr. W. J. Hopkins, of Worcester, and the contractors Mr. Lacey and Mr. Snow, of Droitwich. About a yard of concrete has been laid under the walls, to secure the edifice from damp and give a firm foundation.

The chief stone of the Cranmer Wesleyan Chapel and Schools, at Boundary-street, Vauxhall, has just been laid. The designs, which are in the Gothic style, were furnished by Mr. James Wilson, of Bath, architect. Messrs. Williams and Stone, of Liverpool, are the contractors. The cost is estimated at 9000*l*.

The works connected with the new bridge at Rochester are almost completed. A public promenade, to extend along the Medway, from the new bridge to the baths, has been under consideration by the wardens, and a plan adopted for carrying out the undertaking. A model is to be placed in the Corn Exchange, Rochester, for exhibition. The ceremony of opening the new bridge will take place early this month.

Messrs. Bellamy and Hardy, architects, of Lincoln, have been appointed to erect the new market-house at Long Sutton, which will be proceeded with immediately.

A church is being erected at Umballah, North-west Provinces, India, from the design and under the superintendence of Capt. G. F. Atkinson, Bengal Engineers. The tower and spire will be 200 feet high, the nave 117 feet by 30 feet, the chancel 50 feet by 26 feet, the walls 45 feet high to roof, top of roof 65 feet. The church, when completed, it is said, will be one of the finest in India.

The tender made by Mr. James Marriott, of Coventry, for the drainage and water supply of Warwick, has been conditionally accepted by the Local Board of Health. There were sixteen tenders sent in, four under 10,000*l*. and twelve from that to more than 15,000*l*. As the committee could not spend more than 10,000*l*., only the four tenders under that amount were considered, viz. Edward Knight, Manchester, 9542*l*. 7*s*. 7½*d*.; James Marriott, Coventry, 9948*l*. 3*s*. 6*d*.; George Steene, Lichfield, 9432*l*. 9*s*.; and Rumble and Vint, ditto, 7916*l*. 16*s*. 4*d*. On resolving that Mr. Marriott's tender be accepted, it was also agreed that Mr. John Disney be engaged as chief superintendent of the works, and that Mr. J. W. Croker, of London, be the assistant.

The annual *conversazione* of the Architectural Museum will be held in the rooms of the Museum on Wednesday, the 16th inst., instead of the 2nd inst., as announced in the cards of the summer session.

COMPETITIONS.

The designs of Messrs. Bidlake and Lovatt, of Wolverhampton, have been chosen for the chapels to be erected in the new cemetery at Chesterfield. The chapels will be under one roof, but quite distinct from each other, built in the Geometric style, of stone from the Wingerworth Bole-hill quarries, with dressings of Horton stone. The second premium was awarded to Mr. Drury, of Lincoln.

The competition for the two chapels to be erected in the new cemetery at Bolton has been decided in favour of Mr. Charles Holt. Mr. Robert Burrows, builder, has contracted to complete them for 1222*l*.

The committee appointed to conduct the erection of the new Corn Exchange at Devizes have awarded the premium of 20*l*. to Mr. Charles Phipps, architect, of Bath, for a design in the Roman style. The estimated cost is 1500*l*. There were twenty-six competitors.

It is stated that the committee of the Manchester Exhibition Building have adopted the design of Mr. Edward Salomons, of Manchester, to be carried out by Messrs. C. D. Young and Co., ironfounders, the firm with whom they were in treaty before they invited designs in competition, and that the amount of contract is 25,000*l*.

The design of Mr. Knightly, of Cannon-street, has been selected for the New Presbyterian church, De Beauvoir-town. The first premium has been awarded to Mr. W. Lee, and the second to Mr. Robert Lamb, of South Shields. The competition was a limited one, five architects only having been invited to submit designs.

Designs and tenders for the erection of a bridge across the river Exe, at Bourn, about eight miles from Exeter, are invited to be sent in on or before the 12th inst. Particulars may be obtained at the Land Drainage Company's Offices, 30, Parliament-street, London.

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As was to be expected, in consequence of only sketches on a small scale being required in the first instance, an unusual number of designs were sent in,—no fewer than 115, from among which sixteen have been selected by the examiners as those which are to be admitted to the second competition. So far all looks well: at any rate, those whose sketches are already rejected will have been spared the labour of making complete sets of large finished drawings, while those who will now have to do so must, though all cannot be ultimately successful, feel flattered by the preference given them, since it may be taken for granted that, being fully aware of the attention the unusual course they have adopted would excite, and that the eye of the whole profession is upon them, the committee have diligently scrutinised all the selected designs. It would, perhaps, have been better had the second competition been limited to a smaller number, for except that the being thus selected is a compliment, those who do not obtain the premiums will incur no small amount of additional labour. Their ideas have been already shown, and finished drawings are not likely to prove, as far as ideas are concerned, much more than fair copies of the original sketches, unless, indeed, it has been intimated to the respective parties what amendment is desired, and sufficient time allowed for improving upon first ideas. Not having seen the designs, we cannot pretend to speak positively, therefore can only say that, in our opinion, it would have been all the better if, after the first general "weeding-out," there had been a second one. However, the present is but a first experiment—let us hope it will prove a successful one—with the view of introducing an improved system of competition. A beginning has been made, and for amendment there is no doubt room; and it would perhaps be one, were, instead of two premiums being offered, the number of the final competitors to be so reduced that out of what would else be expended as premiums each would receive a tolerably fair remuneration.

Who, on the present occasion, are among the excluded from or the admitted to the second competition, we cannot say. In all probability the next Architectural Exhibition will show us a good many of the drawings produced on both occasions. Even before then the result will be known, and we trust something besides, for we shall have reason to feel disappointed should not the committee, after having already departed from the usual course, not depart still further from it by eventually publishing some report or statement of their proceedings, for they would thereby set a most excellent and salutary example.

THE PARKS.

The question of the road into St. James's Park has been accorded by the unanimous votes of the House of Commons, and the projected improvement will be commenced forthwith. Some surprise has been evinced at the largeness of the estimate for throwing open a road from St. James's Palace to the park; 4500*l.* certainly is a large sum, and at first sight does appear extraordinary, but on inquiry it is found that the works will be of a more extensive character than originally imagined. That portion of St. James's Palace Gardens, which is to be used for the new road, consists of a raised earthen terrace of about 6 feet in height. The whole of this large mound of earth, consisting of some thousands of loads, will have to be carted away; and then a long new wall and railing will have to be erected. Again, on the other side of the road, that portion of the paved thoroughfare now used will have to be thrown into the gardens of Marlborough House, which will further necessitate the erection of a new wall and the turning of the present hardened road into garden ground.

But, while the inhabitants of St. James's and Belgravia have obtained their point, the frequenters of Kensington Gardens have not been lost sight of. Great improvements are now being carried out, which will add materially to the beauty of the gardens. The broad path from where the band plays on a week day to the bridge is to be continued on the north side of the Serpentine, through the beautiful avenue of trees which runs from the bridge to the Bayswater-road. This path, when completed, will be one of the finest things of the kind in Europe. Again, the hollow at the corner of the bridge, where the carriages now set down, is to be filled up and raised to a level with the road close to the bridge.

SIR CHARLES BARRY'S REMUNERATION.

At a special meeting of the Liverpool Architectural Society, held on the 11th ultimo, the following resolutions in connection with this important question were passed:—

"That after due consideration of the correspondence, printed by order of the House of Commons, on the subject of the difference between Sir Charles Barry and the government as to the rate of remuneration for that gentleman's services as architect of the New Palace at Westminster, this meeting is of opinion—

"That the grounds upon which is based the refusal of the rate of payment, established by long custom, of 5 per cent., are altogether untenable, and completely met by Sir Charles Barry when he argues 'that the unusual extent and importance of the work is a reason rather for increasing than diminishing the customary remuneration of the architect, inasmuch as his responsibilities are more than proportionably increased, and the demands upon his taste, skill, and judgment, far greater, than in works of less magnitude and importance.'

"That as the great difficulties which the architect has to contend with in the practice of his art lie chiefly in the necessity of forming, out of a multitude of divers features designed for distinct utilitarian purposes, one consistent artistic whole, we consider that his task becomes more arduous in proportion to the importance and multiformity of the edifice, and even in proportion to the expenditure when that is incurred for the production of an elaborate style of decoration; and we deem it obvious to the common sense of mankind that the practitioner in no profession can be better entitled to his accustomed fees than the competent architect, to whom a building, however costly, is entirely indebted for its practical and artistic value, and without whose aid it must be but a lifeless mass of constructed lumber.

"That in the opinion of this meeting this reasoning will especially apply to the New Palace at Westminster—an edifice designed to serve practical and complex purposes of great national importance, and to display qualities which shall aid in refining and elevating the public taste.

"That the refusal by the government of the customary rate of remuneration to the architect of this work appears to us to ignore the professional rank which we claim for the practice of architecture; to be inconsistent with the paternal and fostering care which a popular government should extend to the growing appreciation of architecture among the people, which must inevitably be impeded by any depreciation of its claims in so high a quarter, and, if persisted in, be calculated directly and seriously to injure the profession at large.

"That the earnest attention of the Royal Institute of British Architects, as the chartered representatives of the profession generally, be invited to this subject, with a request that they will take such steps as may seem to them advisable to assert and maintain the due claims of the profession, as some movement on their part in the matter cannot altogether fail of effect; since if it do not succeed in inducing the government to reconsider the case it will yet stand as a protest of the profession against the reduction of professional charges; whilst, on the contrary, silence with respect to it on the part of the Royal Institute of British Architects might be misconstrued into acquiescence in its justice."

A copy of the above resolutions was transmitted to the honorary secretaries of the Society, and has been referred to a committee.

In their difference with Sir Charles Barry the government rest on what they consider a bargain made in the first instance, though reluctantly, by Sir Charles. It is most important that a protest should be made against the proposed arrangement, lest it should be adopted as a precedent. There can be no question that for the skilful manner in which he has carried out his arduous task, Sir Charles is justly entitled to, at least, the customary remuneration of architects, five per cent.

Welding Steel.—Mr. H. Anderson, of Garratsville, New York, has secured a patent for an improvement in welding steel, in the specification of which the patentee states that he is aware that alkalies have been used for the purpose, both simple and compound; but his claim is for a compound of sulphate of soda and carbonate of soda, as a vehicle in the welding of steel and securing strength at the junction.

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HARTLEPOOL DOCKS.

The third dock at West Hartlepool, together with a graving dock, have just been opened. The company's harbour and dock works consist at present of—the tidal or outer harbour, 44 acres; first dock (coal), 8 acres; second (coal and merchandise), 14 acres; and third (for merchandise only), 10 acres; besides ten acres for timber float and store yards, with two graving docks, one 320 feet, and the other 350 feet in length. The harbour, docks, quays, staiths, and terminal dock arrangements occupy a total space of 145 acres, which has been covered in little more than eight years. For the conversion of the bay of Hartlepool into a harbour of refuge, the directors stated at a recent general meeting of the proprietors, that an Act of Parliament was obtained, and the port commissioners intend to construct two large piers or breakwaters to shelter the entire bay, and thus form an outer harbour of nearly 1000 acres in extent, accessible to the largest merchant ships in all weathers and states of the tide.

INSTITUTION OF CIVIL ENGINEERS.

May 20.—ROBERT STEPHENSON, Esq., M.P., President, in the Chair.

The Paper read (in abstract) was "*On the Improvement of Railway Locomotive Stock, and the Reduction of the Working Expenses.*" By DANIEL KINNEAR CLARK, Assoc. Inst. C.E.

It was stated that the design of the Paper was to discuss the locomotive engine physiologically:—to consider some departments of practice which appeared to be in a transition state;—to endeavour to indicate how far, in some respects, the locomotive, even in its present advanced state of existence, was susceptible of improvement, and to form some estimate of the pecuniary advantages thus derivable. The three elements of the locomotive,—the boiler, the engine, and the carriage,—were considered successively.

With respect to the boiler, the fuels in use, in this country, were stated to be coke and coal. The author had, in a previous Paper, shown, by mechanical analysis, that the combustion of coke in the locomotive was practically complete; and he adduced, in corroboration, the results of a subsequent chemical analysis of the gases of combustion, by M. Ebelmen, in the engines of the Paris and Lyons railway. In the combustion of coal, which consisted chiefly of carbon and hydrogen, the production of smoke was ascribed to the presence of the hydrogen, which had a stronger affinity for oxygen than carbon had, and thus precipitated the carbon particles raised in union with it, in the form of smoke; and it was maintained that, to effect the consumption, or prevention of smoke, two conditions of supply must be observed,—a sufficiency of oxygen, and a sufficiently high temperature. For these conditions it was argued that, in locomotive practice, strength of draught, and a means of equalising the temperature, were necessary to neutralise the evil of intermittent firing, and the unavoidable fluctuations of temperature.

The author adduced, in evidence, the results of trials, made by him, in 1850-51, and by Messrs. Woods and Marshall in 1854, which showed, that in the prevailing type of boilers, the evaporative powers of good coal and good coke were as 2 to 3: coal doing mechanically just two-thirds of the duty of coke. He proceeded to give an account of recent trials made by him, in the beginning of this year, with the "Canute," on the London and South-Western Railway, one of Beattie's passenger-locomotives, planned expressly for the combustion of coal and the heating of feed-water. A pile of fire-bricks, through which the products of combustion must pass, was deposited in a combustion-chamber joining the fire-box and the tubes, to act as an equaliser of temperature. The hind compartment of the fire-box also was arched over with fire-bricks. The heating apparatus was in two parts,—the condenser outside, which acted by throwing the feed-water in jets amongst the exhaust steam,—and the superheater inside the smoke-box, through which the feed-water was also passed just before entering the boiler. The cylinders were 15 inches diameter, with a length of stroke of 21 inches,—driving wheels 6½ feet,—fire-grate area 16 square feet,—heating surface 769 square feet,—and the weight of bricks was 5¾ cwt. It was found, that in the "Canute" the prevention of smoke was completely attained, with ordinary care and attention; that the evaporative power of the coal was materially improved; and that the heating apparatus was decidedly beneficial. With the regular express trains, the following results were obtained:—average express train, of 10½ carriages, estimated at 66 tons weight; average speed, excluding stoppages, 34 miles per hour; water evaporated on duty, 82 cubic feet per hour of the time the steam was on the piston; corresponding consumption of coal, 547 lb. per hour, and 15 lb. per train-mile; water evaporated per pound of coal, 9·35 lb; average temperature of feed-water, 187° Fah. Special train, of 28 carriages, weighing 203 tons; average speed, 30¾ miles per hour; water evaporated as before, 130 cubic feet per hour; coal per hour, 915 lb., and per train-mile 28¾ lb.; water evaporated per pound of coal, 8·87 lb.; temperature of feed-water, 212° Fah. It was argued that, on Beattie's system, an economy of 36 per cent. of coal was effected in comparison with ordinary engines burning coal; and that this system was on a footing of equality with coke-burning engines, in evaporating efficiency of fuel, weight for weight.

The water supplied to locomotive-boilers was stated to be generally impure, mechanically or chemically, and to affect very injuriously the durability of the engine, reducing, in one case, the durability of the tubes from eight or nine years, with soft water, to three years, with hard water. The loss by priming with bad water was shown to be considerable. It was concluded, that the water supplied to locomotives should be previously purified, chemically and mechanically, in large tanks or reservoirs.

With respect to the engine proper, the author maintained that the link-motion was a sufficient and satisfactory expansion-gear; that its merits were not appreciated; and that in the ordinary practice of expansive working in locomotives, the steam was not cut off earlier than at 40 to 50 per cent. of the stroke; but that, with proper arrangements, it might be cut off at one-fifth. He argued also that the steam should be superheated, and the cylinders perfectly protected; and that the slide-valves should be balanced.

With respect to the carriage, a *resume* of the early and current practice of engine builders was given, from which it appeared, that the system of six wheels, with central drivers, was the prevailing practice. It was argued, that this system was best adapted to secure the main objects in the carriage,—a sufficiency of driving weight, and free and steady running at high speeds, with the important proviso, that the revolving and reciprocating masses of the pistons and cranks, and their connections, should be balanced in the wheels. Evidence was adduced, in proof of the economy of fuel effected by a correct equilibration of the engine.

In conclusion, an estimate was formed of the economy of working expenses due to the improvements described on the assumptions,—first, that the consumption of fuel was an index to the working charges generally of the locomotive stock; second, that the average costs per ton of coal and coke, for locomotive purposes, were as 2 to 3 generally; and third, that the feed-water supplied to boilers was generally impure.

The following was an abstract of the successive items of economy of working charges, separately estimated:—

By the successful substitution of coal for coke	33	per cent.
By efficiently heating the feed-water	15	,,
By the use of pure feed-water	10	,,
By protecting the cylinders and superheating the steam	10	,,
By increased expansive working	25	,,
By the correct equilibration of the engine	10	,,

The gross resulting economy would then be represented, not, of course, by the direct sum of these per centages, but by the result of the successive reductions obtainable by their successive application. Thus, after making the first deduction of 33 per cent., there would remain a balance of 67 per cent. to be operated upon for the second deduction, which was 15 per cent.; but 15 per cent of 67 was equivalent to 10 per cent. of the original quantity, and would leave 67—10=57 per cent.; the third deduction to be made was 10 per cent. of 57, or 5·7 per cent. of the original, leaving, 51 3 per cent. as the balance to be operated upon for the next deduction. Continuing the operation in this manner, the gross resulting economy would amount to about 70 per cent. of the existing average working charges. Allowing for contingencies in the estimate, 50 per cent. was adopted by the author, as the probable average saving that might be effected in the consumption of fuel, and generally in the working charges of the locomotive stock of the railways of the United Kingdom.

The average apportionment of the receipts on the railways of this country was stated to be as follows, on the authority of Mr. Chattaway:—

Working charges	46½	per cent.
Interest on guaranteed capital	28½	,,
Dividends in respect of ordinary shares	25	,,
Gross receipts	100	

Also that the average cost of locomotive power was 29·3 per cent. of the receipts; consequently the saving estimated by the author would be one-half of this, or 15 per cent. of the receipts, and would raise the available dividends from 25 to 40 per cent. of the receipts; or from the average on ordinary share capital, stated by Mr. Chattaway as 3·14 per cent., to a dividend of 5 per cent. per annum.

It was announced, that as it had been necessary to read the Paper only in abstract, it would within a short period be printed *in extenso*, in order that copies might be transmitted to such members as would apply to the secretary for them, and that the discussion upon the subject would take place on Tuesday, 11th November 1856, the first meeting of the Institution after the recess.

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NEW PATENTS.

PROVISIONAL PROTECTIONS GRANTED UNDER THE PATENT LAWS AMENDMENT ACT.

Dated February 23.

461. J. Gedge, Wellington-street South—Improvements in preparing and combining metallic substances for producing colours, and in manufacturing the same. (Communication)
462. J. M. Boyde, Hither-green, Lewisham, Kent—Improvements in scythes

Dated March 6.

564. T. Tisdall, Reynoldstown-house, Dublin—Improvements in machinery or apparatus for propelling steam vessels

Dated March 22.

689. C. Carey, Union-grove, Wandsworth-road—An improvement in omnibuses

Dated April 4.

820. J. G. Martien, Newark, New Jersey—Improvements in the manufacture of iron.

Dated April 7.

836. J. Gedge, Wellington-street south—Improvements in tiles for buildings. (Communication from C. Pandosy)

Dated April 17.

917. L. Mesure, Billericay, Essex—An improvement in watches
918. S. Eyre, Bouverie-street—An improved application of portable mirror
919. J. Luntley, Broad-street—A new fabric or new fabrics suitable for wearing apparel and other purposes to which textile fabrics are applicable
920. J. S. Wright, Birmingham—Improvements in the construction and ornamentation of belt or band fastenings

Dated April 18.

921. G. Larig, Adelebsen, Hanover—Improvements in the process of manufacturing saltpetre
922. W. Westley, Wellington, Derby—A new or improved nail or spike
923. W. Tytherleigh, Birmingham—A new or improved method of coating or covering iron or articles of iron with copper or alloys of copper
924. J. Marsh, Burnt Tree, near Dudley, Worcester—Improvements in fire-grates
925. W. Budden, Ipswich—Improved method of preparing cheques, invoices, and other papers, so that they may be readily separated from their counterparts
926. C. F. Stansbury, Gracechurch-street—An improved mode of splicing and fastening the adjacent ends of the rails of a railway track. (Communication)
927. T. Hollingworth, Turkey Mill, near Maidstone—Improved machinery for dusting or cleaning rags
928. U. Scott, Camden Town—Improvements in metal fittings for furniture
929. E. V. Gardner, Norfolk-street, Middlesex Hospital—Improvements in furnaces
930 T. Walker, Birmingham—Improvements in governors or regulators of steam and other motive power engines
931. G. Thompson, Marchamont-street, Russell-square—Improvements in instruments or apparatus used in drawing or marking with crayon, black-lead, or other such materials
932. J. Jeffreys, Kingston-hill, Surrey—Improvements in instruments for aiding respiration
933. P. W. Barlow, Great George-street, Westminster—An improvement in seasoning timber
934. J. G. Jennings, Great Charlotte-street, Blackfriars-road—Improvements in pumps

Dated April 23.

969. T. Myers and G. Myers, Retherham—An improved 'fire-lighter'

Dated April 24.

980. A. S. Stocker, Poultry—Improvements in the application of certain materials to the manufacture of ink and other stands, and other articles, and in the manufacture and finishing of articles produced out of such or other material or materials

Dated April 25.

992. G. Elliott and W. W. Pattinson, Newcastle-on-Tyne—Improvements in the production of peroxide of manganese
997. R. Lakin, Stretford, Lancaster, J. Thompson, E. Fitton, and F. A Fitton, Manchester—Improvements in or applicable to certain machines for preparing and spinning cotton and other fibrous substances, some or which improvements relating to apparatus for lubricating, and to the construction of studs, are also applicable to machinery for other purposes

Dated May 6.

1062. O. Blake, Thames Plate Glass Works, Blackwall—Improvements in applying practically the principle of internal reflection within transparent substances
1064. W. J. Curtis, Sebbon-street, Islington—Improvements in constructing the permanent way of railways
1066. W. E. Newton, Chancery-lane—Improved machinery for making envelopes. (Communication)
1068. R. A. Brooman, Fleet-street—Treating guano and other matters containing uric acid, and the manufacture from the products arising from such treatment, as well as from uric acid, of new colouring matters, and the fixing and application thereof. (Communication)

Dated May 7.

1069. J. Furnevall, Haslingden, Lancaster—Improvements in the construction of valves
1070. G. Martin, Windmill-terrace, Camberwell, and A. L. Newman, New Church-street, Bermondsey—Improvements in freeing or purifying animal fibres from admixture with vegetable matters
1071. W. J. Curtis, Sebbon-street, Islington—Improvements in carriages to run on rail or tram ways and common roads
1072. R. Heaton, jun., H. Heaton, and G. Heaton, Birmingham—New or improved manufacture of balance weights used for counterbalancing pendant lamps and chandeliers, and for other like purposes.
1073. S. A. Bell and J. Black, Bow-lane—Improved method of, and preparation for, igniting matches
1074. J. Périnaud, Paris—Improvements in preparing or dressing silks
1075. R. Royds, Southampton—Improvement or improvements in the manufacture of soap

Dated May 8.

1076. L. G. Perreaux, Rue M. le Prince, Paris—An improved valve
1077. C. Schneider and F. Leiss, Hesse Darmstadt—Manufacturing a safety boiling apparatus
1078. L. F. Mayer, Regent-street—Improvements in photography
1079. A. E. Riddle, Walbrook, and I. H. Boyd, Mansion-house-place—The improvements in tanning by machinery and chemicals. (Communication from G. F. Kendall)
1080. J. Niven, Keir, Perth—Improvements in the manufacture of paper, and in the production of textile materials
1081. J. G. Lawrie, Glasgow—Improvements in steam-engines
1082. J. Amory, Boston, U. S.—Improvements in furnaces for locomotive and other steam boilers, which improvements are applicable to reverberatory and puddling furnaces, and to furnaces for heating buildings
1083. C. W. Finzel, Bristol, W. Needham, Smallbury-green, Middlesex, and J. Barton, Shoe-lane—Improvements in apparatus for filtering sugar and saccharine juices
1084. R. A. Brooman, Fleet-street—Improvements in machinery for felting or sizing hat bodies (Communication)
1085. A. Alliott, the Park, Nottingham—Improvements in drying apparatus
1086. W. E. Newton, Chancery-lane—Improved machinery for cutting, punching, and forging, or swaging nuts or washers. (Communication)
1087. A. C. L. Devaux, King William-street — Improvements in the construction of granaries
1088. A. V. Newton, Chancery-lane—An improved construction of rotary pump. (Communication)
1089. A. V. Newton, Chancery-lane—An improvement in bands for securing bales of goods, and for other like uses. (Communication)
1090. S. W. Underhill, Wellfield Cottage, Dunse—The preservation of life in cases of shipwreck or other casualty at sea, the Buoyant Cushion

Dated May 9.

1091. L. L. Jardin and J. Diamond, Rue de l'Echiquier, Paris—Improvements in engraving on stone, earthenware, china, and glass, and also in ornamenting the same
1092. W. Baylis, Wolverhampton—Improvement in chains for collieries, cables, and other purposes
1093. J. H. Johnson, Lincoln's-inn-fields—Improvements in carding engines for cleaning cotton and other fibrous materials. (Communication from C. Wellman, Lowell, U. S.)
1094. J. W. Hackworth, Priestgate Engine-works, Darlington—Improvement in machinery or apparatus for raising and lowering heavy bodies
1095. F. Potts and T. Vann, Birmingham—Machinery for ornamenting, floating, burnishing, and polishing metallic tubes, part of which machinery is also applicable for performing the like operation upon other metallic surfaces
1096. E. D. Johnson, Wilmington-square—An improved mode of mounting marine chronometers
1097. G. J. Firmin, Newton-le-Willows—Improvements in the manufacture of sulphuric, tartaric, citric, and oxalic acids, ammonia, and cyanides
1098. W. E. Wiley, Great Hampton-street, Birmingham—Improvements in the manufacture of pens and pen-holders
1099. W. Basford, Talbot-road, Kentish Town—Improvements in apparatus for purifying coal gas
1100. L. Beauché, Offenbach, near Frankfort-on-the-Maine—A machine for the manufacture of cigars
1101. G. Simpson, Leather-lane—Improvements in rotary knife-cleaning machines
1102. R. A. Brooman, Fleet-street—An improvement in cranes. (Communication from C. R. Neustadt)
1103. R. A. Brooman, Fleet-street—Improvements in machinery for the manufacture or finishing of tyres, hoops, and rings. (Communication from A. Dubuy, Givors)
1104. F. R. Laurence, Southampton-street—An improvement in the manufacture of shirt collars and wristbands

Dated May 10.

1105. R. A. Brooman, Fleet-street—Improvements in machinery for manufacturing tubes and pipes, applicable also to the rolling of rods and bars. (Communication)
1106. J. Binns, Dukinfield, Chester—Improvements in machinery or apparatus for winding, sizing, and beaming yarns
1107. J. H. Johnson, Lincoln's-inn-fields—Improvements in machinery or apparatus for cutting irregular forms. (Communication from H. D. Stover and J. W. Bicknell, Boston, U. S.)
1108. J. Wallace, jun., Glasgow—Improvements in preparing, blanching, washing, cleansing, and drying textile fabrics and materials and pulpy substances
1109. R. Wotherspoon, Glasgow—Improvements in hats and other coverings for the head
1110. J. H. Johnson, Lincoln's-inn-fields—Improvements in drying leather and dressed skins. (Communication from Arthus Brothers, Paris)
1111. J. Ridal, Sheffield—Improvements in spring knife handles
1112. W. Burkin, Neate-street, Old Kent-road—Improved machinery for manufacturing painted cloths
1113. B. Benlowski, Bow-street, Covent-garden—Improvements in typographical composition, and in the manufacture of logotypes to be used therein

Dated May 12.

1114. C. F. Claus, Latchford, Chester—Moistening land, streets, and the better extinction of fires
1115. P. E. Aimont, Paris—Improvements in manufacturing shoes and other coverings for the foot
1116. R. Whytock, Edinburgh—Improvements in apparatus to facilitate the printing of yarns or threads
1117. E. B. de la Pontoeerie, Paris—Improvements in the apparatus for consuming smoke. (Communication)
1118. B. Samuel, Sheffield—Improvements in the manufacture of combs
1119. W. E. Newton, Chancery-lane—Improvements in machinery for pumping and forcing water and other fluids. (Communication from G. Denison, U. S.)
1120. W. E. Newton, Chancery-lane—Improved machinery for splitting or cutting blocks of wood for match splints, kindling wood, trenails, and other purposes. (Communication)

Dated May 13.

1121. C. B. Clough, Llwyn Offa, Flint—Improvements in elongating and contracting metal bars or rods for the obtainment of motive power
1122. M. H. Simpson, Massachusetts, U.S.—New and useful improvements in machinery for combing wool or various other fibrous substances
1123. A. Parkes, Birmingham—Improvements in the use of collodion in photography
1124. H. Tucker, Massachusetts, U.S.—An improved spring sacking or foundation for a bed mattress, or other like article
1125. A. Parkes, Birmingham—An improvement in preparing materials for and in waterproofing and coating woven and other fabrics, paper, leather, and other substances
1126. C. Boosey, Holles-street, Cavendish-square—Improvements in music stands for the use of military and other bands. (Communication)
1127. R. Raywood, Penistone, York—Improvements in railways
1128. W. E. Newton, Chancery-lane—Improved apparatus for generating illuminating gases from coal or other substances. (Communication)
1129. W. E. Newton, Chancery-lane—Improved machinery for removing snow from railroad tracks. (Communication)
1130. W. E. Newton, Chancery-lane—The novel application of certain substances to be employed in printing upon woven or other fabrics and paper. (Communication)

Dated May 14.

1131. H. Bragg, jun., Belfast—Improvements in machinery or apparatus for finishing linen and other fabrics

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1132. W. Galloway and J. Galloway, Manchester—Improvements in machinery for rasping, cutting, and chipping dye woods
1133. H. Groves, New York, U.S.—Improvements in tune barrels or cylinders, or other apparatus for playing upon organs or other musical instruments
1134. J. H. Riddell, Sherborne-lane—Improvements in stoves or fire-places
1136. J. A. Drieu, Patricroft, near Manchester—Improvements in weaving horse-cloths, blankets, rugs, or similar thick materials
1137. A. Tolhausen, Duke-street, Adelphi—An improved distance indicator for public carriages. Communication from C. A. L. Mannory, Berlin)
1138. U. Scott, Camden-town—Improvements in public carriages, and various parts of the same, which parts may be used separately, and applied to vehicles of any description
1139. G. P. Harding, Kingsland — An improvement in the manufacture of cloth bonnets
1141. C. H. Olivier, Finsbury-square—Improvements in the mode of preparing and applying silk waste. (Communication)
1142. C. Gibson, Draycott, Derby—Improved machinery for the manufacture of bricks, tiles, pipes, and other articles made of clay or plastic materials
1143. W. Crofts, Derby-terrace, Nottingham-park—Improvements in the manufacture of lace and other weavings
1144. W. H. Harfield, Fenchurch-street—Improvements in machinery for cutting and smoothing the surfaces of metallic nuts. (Communication)
1145. W. Evans, Sherston, Malmesbury—An improved description of plough

Dated May 15.

1146. J. Cox, Ivy-bridge Cottage, near Caerleon, Monmouthshire—Improvements in coke and coke ovens
1147. R. Walker and A. M'Kenzie, Glasgow—Improvements in electric telegraphs
1148. W. Norris and R. King, Liverpool—Improvements in anchors
1150. J. Leck and A. Miller, Glasgow—Improvements in singeing textile fabrics
1152. H. Greaves, New Palace-yard, Westminster—Improvements in the permanent way of railways
1153. C. R. Williams, Shiffnal, Salop—A new or improved implement or apparatus for the cultivation of land
1154. R. A. Brooman, Fleet-street—An improvement in stuffing seats, cushions, furniture, and other similar articles. (Communication from P. Touben, Paris)
1155. S. W. Moore, Nottingham—Improvements in dividing and finishing lace goods
1156. W. Marjoribanks and J. Griffiths, Haverfordwest—Improvements in horse rakes, part of which is applicable to two-wheel carriages
1157. M. Townsend, Leicester—Improvements in the manufacture of knitted fabrics
1158. W. Smith, Salisbury-street, Adelphi—A new application of the syphon as an irrigator, and a motive power machine. (Communication from M. A. Herault, Angers)

Dated May 16.

1159. W. Thistlethwaite, Verulam-buildings, Gray's-inn—Improvements in photography. (Communication from L. Angamarre, Paris)
1160. J. Martin, Liverpool—Improvements in machinery for draining or partially drying certain descriptions of wheat and other grain
1161. W. Harker, Victoria Mill, Bowley, Bradford—Improvements in giving motion to rotating shuttle-boxes of power looms
1162. W. Henderson, Dunkeld—Improvements in the manufacture of brooms
1163. E. Eaborn and M. Robinson, Clement-street, Birmingham—Improvements in machinery for grinding or reducing sugar
1164. A. Barclay and J. Wallace, Kilmarnock—Improvements in apparatus for the manufacture and measurement of illuminating gas
1165. J. Mellor, Gorton, near Manchester—Improvements in grates or grids, applicable to sewers, drains, and other similar purposes

Dated May 17.

1166. R. Coleman, Chelmsford—Improvements in implements for ploughing, hoeing, and scarifying land
1167. D. Curwood, George-street, Grosvenor-square — An improved apparatus for facilitating the cleaning of knives and forks
1168. S. C. Kreeft, Fenchurch-street—Improvements in the manufacture of iron and steel. (Communication)
1169. A. V. Newton, Chancery-lane—Improvements in machinery for forging or pointing wrought nails, spikes, and other four-sided articles. (Communication)
1170. G. Scheurmann, Newgate-street—Improvements in printing music
1171. L. Cornices, Trafalgar-square—Improvements in ornamental window blinds, and such like transparent decorations
1172. J. J. Meyer, Tatham-street, Rochdale—Improvements in machinery for mortising, tenoning, rounding, sweep and straight moulding, boring, grooving, and mitreing
1173. J. Hynam, Princes-square, Wilson-street, Finsbury—An improvement in the manufacture of instantaneous lights when of paper or cotton
1174. C. Titterton, Roehampton, Surrey—Improvements in the manufacture of zinc and zinc white
1175. R. Knight, Foster-lane—Improvements in apparatus for aerating liquids
1176. R. M'Cloy and J. Hare, Glasgow—Improvements in spinning and twisting fibrous materials and in the machinery or apparatus employed therein
1177. C. C. Tevis, Paris—An improved revolver
1178. G. Carter, Mottingham, Kent—Improvements in the mode of propelling and steering vessels, and in the apparatus and machinery applicable thereto

Dated May 19.

1179. J. Wilkes, T. Wilkes, and G. Wilkes, Birmingham—A new or improved manufacture of rollers or cylinders for printing fabrics
1180. J. Brown, Kingswinford, Stafford—New or improved machinery to be used in the manufacture of iron
1181. J. L. Bowhay, Modbury, Devon—Improvements in drills for sowing seeds and distributing manure or water
1182. G. Clark, Great Cambridge-street, Hackney-road—Improvements in the manufacture of illuminating gas
1183. M. H. Picciotto, Crosby-square—Improvements in preparing flax, hemp, and other similar fibrous materials
1184. J. K. Smythies, Kensington-park-gardens — Improvements in apparatus or instruments for ascertaining the points of the compass, and the latitude and longitude of a place
1185. J. Wilkes, T. Wilkes, and G. Wilkes, Birmingham—A new or improved manufacture of rollers or cylinders for printing fabrics

Dated May 20.

1186. W. Fowler and W. M'Collon, Kingston-upon-Hull—Improvements in portable steam-engines, applicable to agricultural and other similar purposes
1187. W. Maugham, Ifield-terrace, Surrey—An improvement in rendering wood fireproof
1188. G. Wilkinson, Evans-street, Poplar—Improvements in steering apparatus, and in giving motion to machinery for raising and moving weights
1189. W. Maugham, Ifield-terrace, Surrey—An improvement in rendering cotton and other fabrics and paper uninflammable
1190. R. Maxwell, Carlton-terrace, North Brixton—Improvements in the construction of taps for drawing off liquids
1191. J. A. Gollop, Lower Sloane-street, Chelsea—An improved method of excluding dust, water, air, and other extraneous matters from doors, windows, glass, show cases and such like constructions
1192. S. R. Toms, Church-villas, Croydon—Improvements in gloves
1193. W. C. M'Bride, Armagh—Improvements in machinery for scutching flax and other vegetable fibrous substances
1194. A. V. Newton, Chancery-lane—An improved mode of preparing the double chlorides of aluminium and sodium, and aluminium and potassium. (Communication)
1195. W. E. Newton, Chancery-lane—Improvements in the process of manufacturing oil from seeds, and in the machinery and apparatus to be used therein. (Communication)
1196. A. V. Newton, Chancery-lane—An improved rotary pump. (Communication)

Dated May 21.

1197. J. H. R. de Castro, Manchester—An improved method of propelling railway or other carriages up inclines. (Communication)
1198. D. Shaw, Gee Cross, Chester—Improvements in looms and apparatus employed therewith for weaving
1199. R. Pemberton, Hildenborough, Tonbridge—Improvements in barrel organs
1200. J. Perron, Buttesland-street, Hoxton New Town—Improvements in ornamenting surfaces of wood, ivory, bone, and such like substances
1201. A. H. Dufresne, Rue de l'Echiquier, Paris—An improved process of gilding and ornamenting steel and other metals
1202. J. Cope, Birmingham—An improvement or improvements in the manufacture of buttons made of pearl or other shell, ivory, bone, or wood
1203. M. Bower and J. Barwell, Birmingham—A new or improved method of joining the parts of metallic and other bedsteads and other articles of furniture
1204. H. Medlock, Great Marlborough-street—Improvements in the manufacture of glass, enamels, and other vitrified substances
1205. J. Holdin and W. J. Doruing, Manchester—Improvements in bouking, bleaching, washing, and cleansing textile fabrics and materials. (Partly a communication)
1206. A. Allan, Perth, and T. Hunt, Crewe, Chester—Improvements in the construction of locomotive and other steam-engines and carriages, and in the rolling stock of railways
1207. G. Heron, South-street, Newcastle-on-Tyne—Improvements in machinery or apparatus for raising, lowering, moving, or transporting heavy bodies
1208. R. H. Schwabe, Glasgow—Improvements in the manufacture or production of ornamental fabrics
1209. M. Neilson, Thorn Mill, Renfrew—Improvements in the treatment, preparation, or finishing of yarns or threads
1210. E. Greenless, Glasgow—Improvements in the treatment, and preparation or manufacture of textile and pulpy materials
1211. C. De Jongh, Lautenbach, Guebwiller, France—An improved method of separating and assorting combed fibres of different lengths
1212. T. Lawrence, Birmingham—Improvements in machinery to be used for grinding and polishing gun barrels, swords, matchets, bayonets, scythes, fire-irons, and other articles similar in transverse section to any of those above named
1213. E. H. Bentall, Heybridge, Essex—Improved machinery for crushing or splitting grain or seeds. (Communication)
1214. W. E. Newton, Chancery-lane—Improvements in machinery for spinning or twisting fibrous substances. (Communication)
1215. W. H. Aston and S. Hopkinson, Zetland Mill, Huddersfield—Improvements in steam-boiler furnaces and apparatus employed for supplying water to steam-boilers
1216. W. J. Curtis, Sebbon-street, Islington—Improvements in the manufacture of iron railway wheels

Dated May 22.

1217. W. Galloway and J. Galloway, Manchester—Improvements in steam-boilers
1218. A. Hubert, Bordeaux—An improved apparatus for ventilating ships or vessels
1219. J. C. Pearce, Bowling Ironworks, near Bradford—Improvements in apparatus for generating and economising steam
1220. W. R. Hodges, Manchester—Improvements in machinery or apparatus for manufacturing loop-pile fabrics. (Communication)
1221. W. C. Dempsey, Liverpool-street, King's-cross—A compound for removing all obstructions of the air passages
1222. A. Tolhausen, Duke-street, Adelphi—Improvements in clock-work, part of these improvements being applicable to other regulating purposes. (Communication)
1223. J. Cutler, Sparkbrook, Birmingham — Improvements in the manufacture of metallic pipes or tubes to be used for various purposes
1225. G. Barruel, Rue Hautefeuille, Paris—Improvements in treating cotton seed
1226. R. Bell, Glassford-street, Glasgow—An improvement in the manufacture or production of ornamental fabrics
1227. C. Dewick, Stanley-street, Leicester — Improvements in machines, generally called "rib frame, or rib machine" for producing fancy hosiery.
1228. J. Howard, Bedford, and G. W. Baker, Woburn, Bedford—Improvements in machinery or apparatus applicable to the tilling of land

Dated May 23.

1229. T. D. Russum, Tipton, Stafford—A new or improved break for steam-engines and other motive power engines
1230. S. Berrisford, Portwood, Chester, and E. Wilkinson, Oldham, Lancaster—Improvements in looms for weaving
1231. J. Gedge, Wellington-street, South—An improved gridiron. (Communication)
1232. J. Gedge, Wellington-street, South—Improvements in looms. (Communication)
1233. J. Gedge, Wellington-street, South—Improvements in machinery or apparatus for winding threads. (Communication)
1234. J. Gedge, Wellington-street, South—Improvements in obtaining a material used in dyeing. (Communication)
1235. J. Gedge, Wellington-street, South—Improvement in machinery or apparatus for the manufacture of billiard cues or similar articles. (Communication)
1237. J. Gedge, Wellington-street, South—Improvements in the application of distillation to gas from the furnaces of steam-engines. (Communication)
1238. G. B. Galloway, Basinghall-street—Improvements in the furnaces of marine boilers, and in the construction of steam vessels
1239. T. Herbert and R. Whittaker, Nottingham—An improvement in the manufacture of warp lace fabrics
1240. J. Dixon, High Bridge, Newcastle-upon-Tyne—Improvements in apparatus for measuring water and other liquids
1241. F. P. Dimpfel, Philadelphia, U.S.—Improvements in the construction of screw nuts for axle-boxes, and other purposes. (Communication)

Dated May 24.

1242. J. de Cockkenifeck, Cork—An improved process and apparatus for preparing, refining, and filtering oils or fatty matters
1243. P. E. L. Barron, Coleshill-street—An improved process for coating metals for sheathing ships and for other purposes, and in the means of attaching sheathing plates to ships or vessels. (Communication)
1244. W. Illingworth, Manchester—Improvements in printing or colouring and glazing china, earthenware, or other ceramic manufactures, and in the machinery or apparatus connected therewith, and also improvements in the subsequent treatment of such manufactures

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1245. A. D. Jundzill, Portugal-street, Lincoln's-inn-fields—An instrument for animating stereoscopic figures
1246. R. A. Whytlaw and A. Mitchell, Glasgow—Improvements in weaving
1247. J. Lea, Birmingham—Improvements in sunblinds
1248. F. P. Dimpfel, Philadelphia, U.S.—Improvements in the construction of steam boilers and furnaces
1249. S. D. Liptrap, Albany-road, Camberwell, and J. Wright, Alfred-place, Newington Causeway—Improvements in apparatus for regulating the mode of supplying and drawing off water and other liquids

Dated May 26.

1250. B. N. de Buffon, Rue du Cherche Midi, Paris—A new apparatus for clarifying and purifying water and other liquids
1251. A. A. Gaget, Rue de l'Echiquier, Paris—Improvements in bookbinding
1252. A. R. Le Mire de Normandy, Judd-street, Brunswick-square—Improvements in obtaining fresh water from salt water
1253. W. Rye, Manchester—Improvements in fixing or fastening rails or railways in their chairs
1254. W. Hulse, Birmingham—An improvement or improvements in metallic and other bedsteads, which improvement or improvements may be applied to other articles of furniture, and to framework generally
1255. C. Cowper, Southampton-buildings, Chancery-lane—Improvements in the treatment of coal, and in the purification, desiccation, and anglomeration of coal, and in machinery and apparatus for such purposes. (Communication)
1256. B. J. Heywood, Leicester-square—Improvements in holders for leads, slate, and other marking materials
1257. F. C. Jeune, Gresham-street—An improved manufacture of floor-cloth
1258. W. E. Newton, Chancery-lane—An improvement applicable to quadrants and other instruments for taking the altitude of the sun or other objects. (Communication)
1259. T. Forster, Brownlow-street—Improved apparatus for holding postage, receipt, and other stamps
1260. S. Newington, Ticehurst, Sussex—A preparation for destroying the fly or aphis, and other insects, on hop and other plants
1261. J. Roberts, Falmouth—Improvements in machinery for moulding bricks and tiles
1262. T. Charlton, Brentwood, Essex, and W. Turnbull, Rotherhithe—Improvements in steam-engines
1263. J. Baird, Edinburgh—A method of freeing the wool upon skins from burrs and other extraneous substances
1264. H. G. Yates, East Smithfield—An improvement in treating wash waters in order to precipitate the greasy and soapy matters contained therein. (Communication)

Dated May 27.

1265. E. Talbot, Spring Vale, Staffordshire—Improvements in the construction of rails for railways
1266. F. C. Hills, Deptford—Improvements in the purification of gas
1267. W. E. Newton, Chancery-lane—Improvements in printing machinery. (Communication)
1268. A. V. Newton, Chancery-lane—Improvements in reaping machines (Communication)
1269. F. P. Dimpfel, Philadelphia, U.S.—Improvements in constructing the permanent ways of railroads

Dated May 28.

1270. L. D. Owen, Southampton-street—Improvements in the manufacture of artificial stone. (Communication)
1271. J. Macdonald, Henry-street, Upper Kennington-lane, Vauxhall—Improvements in the reflection, emission, and radiation of light and heat for lamps, lighthouse apparatus, and other useful purposes
1272. J. Clark, Buckskin-farm, Basingstoke—An improved horse hoe
1273. W. Fulton, Glasgow—Improvements in preparing and spinning fibrous materials, and in machinery or apparatus employed therein
1274. C. H. Holt, Manchester—Improvements in steam-boilers, furnaces for the same, and apparatus connected therewith
1275. G. Bell and G. C. Grimes, Vauxhall-walk, Lambeth—Improvements in the manufacture of frictional matches and fuzees
1276. R. A. Brooman, Fleet-street—An improved coating or composition to be applied to substances in order to render them uninflammable, and in the method of and apparatus for manufacturing the same. (Communication from Madame Boulard)

Dated May 30.

1278. H. J. van den Hout, Covent-garden—Improvements in the preparation of pulp for the manufacture of paper, millboard, and other like purposes
1279. A. Drew, Glasgow, and M. Gray, Bonhill, Dumbarton—Improvements in weaving
1280. D. Bethune, Cambridge-terrace, Hyde-park—Improvements in apparatus for dyeing
1281. W. C. Hutton, Sheffield—Improvements in stamps or hammers worked by power
1282. J. Weems, Johnstone, Renfrew, and J. H. M'Crindell, Glasgow—Improvements in the manufacture or working of metals and their ores
1283. F. L. Stott, T. Belward, and J. Findlow, Manchester—Improvements in machinery or apparatus for washing wool or garments, and other articles made of textile fabrics
1284. J. H. Heal, Tottenham-court-road—An improvement in hair and wool mattresses

Dated May 31.

1285. A. Bouvallet, Rue de l'Echiquier, Paris—Improvements in printing woven fabrics, velvet, skins, and other like materials
1286. F. A. Calvert, Manchester—Improvements in machinery for opening, cleaning, and carding cotton, and other fibrous materials
1287. A. Watson and A. H. Williams, Cornhill—An improvement in bottles, flasks, and other like receptacle for liquids
1289. F. Allman and D. Bethune, Cambridge-terrace, Hyde-park—Improvements in apparatus for separating fluids from solids, or for separating the more fluid particles from the more solid of various bodies
1290. H. Bessemer, Queen-street-place, New Cannon-street—Improvements in shaping, pressing, and rolling malleable iron and steel
1291. R. Jobson, Wordsley, Stafford—Improvements in apparatus for making moulds for casting metals
1292. H. Bessemer, Queen-street-place, New Cannon-street—Improvements in the manufacture of iron and steel
1293. W. Gossage, Widnes, Lancaster—Improvements in the manufacture of certain kinds of soap
1294. D. Spink, Bridgwater—Improvements in rails and railways
1295. F. Fowke, Pall-Mall—An improved portable photographic camera

Dated June 2.

1296. R. Blackwood, Kilmarnock—Improvements in machinery or apparatus for doubling yarns or threads
1298. T. Wilson, Birmingham—An improvement or improvements in screw-wrenches
1299. G. Gidley, Clinger-street, Hoxton, and W. Christopher, Oak Villa, Pinner—Reducing the bottle or imported india-rubber to a transparent liquid state, so that it may be used as a transparent varnish or solution for mixing with colours
1300. S. R. Parkhurst, New York—Improvements in paddle-wheels for steam-boats and vessels
1301. B. J. Heywood, Leicester-square—An improved construction of holder for lead and other marking materials
1302. L. A. Dieudonné, Essex-street, Strand—Improvements in nose-bags. (Communication)
1303. A. Cadet, College-street North, Camden-town—Improved stamping apparatus. (Communication)
1304. A. M. Herland, Paris—A new regulator pen-holder
1305. V. J. B. Mauban, Rue de l'Echiquier, Paris—Improvements in the manufacture of cans for holding oils and other liquids
1306. J. E. M'Connell, Wolverton, Buckingham—Improvements in locomotive engines
1307. D. Avery, Essex-street, Strand—Improvements in the construction of bonnets and other coverings for the head
1308. J. Nasmyth, Patricoft, Lancaster, and J. Brown, Newport, Monmouth—Improvements in apparatus for the manufacture of tin plates
1309. J. Groley, Paris—An improved plough
1310. E. Marsden, Hanley-wood, Derby—Improvements in implements in pulverising and cleaning land
1311. W. Beadon, Otterhead, Honiton—Improvements in agricultural implements for cleaning, cultivating, and rolling land
1312. G. H. Cottam and H. R. Cottam, St. Pancras Ironworks, Old St. Pancras-road—An improvement in the manufacture of iron hurdles

Dated June 3.

1313. T. W. Willett, Chancery-lane—Improvements in the manufacture of gunpowder
1314. G. J. Mackelcan, Islington—Improvements in the manufacture of rollers adapted to calico and other printing
1315. E. Heywood, Sutton-cross-hills, Leeds, and T. O. Dixon, Steeton, near Keighley, York—Improvements in the means of attaching drawer and other knobs or handles
1316. C. R. Wessel, Fitzroy-square, New-road, and F. X. Kukla, Raven-row, Mile-end-road—A vapourless glow-heat disseminator.
1317. J. Bauzemont, Paris—Improvements in purifying turpentine
1318. J. H. Johnson, Lincoln's-inn-fields—Improvements in oil cans employed in lubricating machinery. (Communication from J. F. Berendorf, Paris)
1319. W. G. Whitehead and F. A. Harwood, Birmingham—A new or improved candlestick
1320. J. J. Lebaillif, Falaise, France—Improvements in beating, cleaning, napping, and dressing cotton, wool, flax, tow, and other fibrous substances, and stuffs or woollen cloths
1321. R. Fletcher, Derby, and E. Fletcher, Monk Bretton, York—Improvements in sweeping chimneys or other flues
1322. M. R. Leverson, St. Helen's-place—Improvements in tackle-blocks. (Communication)

Dated June 4.

1325. T. Morris, Bunney, Nottingham—An improved trap for beetles and other insects
1326. F. A. Gatty, Accrington—An instrument to be used in lighting and holding matches or vesta lights
1327. A. Bullough, Blackburn—Improvements in the mode or method of leasing warps
1328. W. Potts, Handsworth, Stafford—Improvements in sepulchral monuments
1329. R. B. Wigley, Birmingham—A new or improved method of attaching handles to coffins
1330. E. Hatton, Birmingham—Improvements in the manufacture of plain and ornamental metallic tubes
1331. D. Morrison, Bordesley Works, Birmingham—Improvements in the manufacture of metallic bedsteads and other articles to sit or recline on
1332. C. L. Marle, Hotel du Continent, Leadenhall-street—Improvements in preserving animal and vegetable substances suitable for food
1333. D. Morrison, Bordesley Works, Birmingham—Improvements in the manufacture of articles from malleable cast-iron
1334. J. Christopher, Heavitree, Devon—Improvements in knives and forks whose handles are not metallic
1335. R. A. Brooman, Fleet-street—Improvements in plating glass to render it reflective. (Communication)
1336. W. Smith, Margaret-street, Cavendish-square—Improvements in apparatus for regulating the supply of air to furnaces
1337. A. L. Gibon and A. Fröhlich, South-street, Finsbury—Improvements in economising fuel in the treatmet of metals

Dated June 5.

1338. J. Betts, Strand—Improvements in the preparation or manufacture of artificial spheres
1339. J. Norris, jun., New York—An improvement or improvements in the manufacture of the cutting tools employed in nail-making machines. (Communication)
1340. J. Le Breton, King's Arms Yard, Coleman-street—A photo-gas or apparatus, with air draughts of hot oxygen when applied to oil lamps, with wicks for lighting and heating. (Communication from F. A. C. Jeune, Paris)
1341. A. E. Brae, Leeds—Improvements in apparatus for communicating signals from one part of a railway train to another
1342. A. Sinclair, Birmingham—An improvement or improvements in wrought-iron pins for railway chair fastenings
1343. W. W. Hewitson, Headingley, near Leeds, and W. H. Bartholomew, Brunswick-terrace, Leeds—Improvements in the construction of the furnaces or fire-boxes of tubular steam-boilers

Dated June 6.

1345. D. Lang, Greenock—Improvements in obtaining and applying motive power
1346. J. Robinson, jun., Hyde, Chester—Improvements in railway chairs, or in means for securing rails thereto
1347. C. Beyer, Gorton, near Manchester—Improvements in locomotive engines
1348. R. Harlow, Stockport—Improvements in the construction of water-closets, and in valves or taps for water-closets and other purposes
1349. J. Somerville, Glasgow—Improvements in weaving
1350. C. D. Gardissal, Bedford-street, Strand—Improvements in machinery for extracting fibrous and other products from vegetable substances. (Communication)
1351. J. Juckes, Dame-street, Islington—Improvements in the furnaces of locomotive boilers
1352. T. Chambers, jun., Colkirk, Fakenham—Improvements in agricultural drills
1353. P. A. Lecomte de Fontainemoreau, South-street, Finsbury—Improvements in heating water for steam-boilers. (Communication)
1354. A. V. Newton, Chancery-lane—Improvements in rotary engines. (Communication)
1355. P. Ellison, St. Helen's, Lancashire—Improvements in furnaces, and the mode of working the same, for the manufacture of black ash or crude soda

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PATENTS APPLIED FOR WITH COMPLETE SPECIFICATION.

1288. W. Needham and J. Kite (secundus), Vauxhall—Improvements in machinery or apparatus for expressing liquids or moisture from substances
1410. H. G. de Châteauneuf, Paris—Improvements in apparatus for washing and bleaching clothes and other materials, to be called "the steam washing lixiviateur"—June 14

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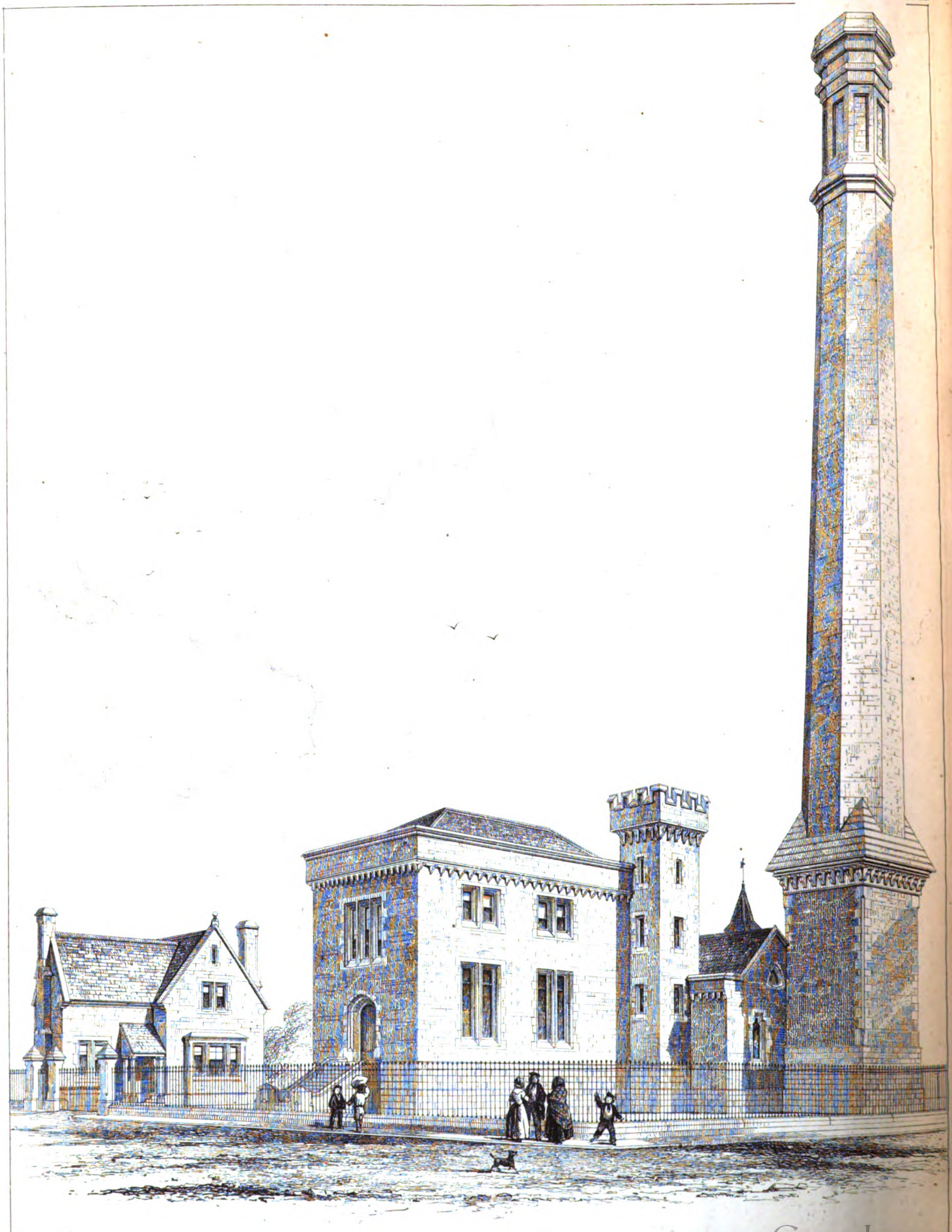

G. W. STEVENSON, ENGINEER

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C. R. Jobbins.

PERSPECTIVE VIEW OF ROTHERHAM WATER WORKS BUILDINGS.

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PERSPECTIVE VIEW OF ROTHERHAM WATER WORKS BUILDINGS

ROTHERHAM WATERWORKS.

(With Engravings, Plates XXI. *and* XXII).

The buildings of which we this month give a perspective view and ground plan, have been erected at Rotherham, Yorkshire, from the designs of Mr. G. W. Stevenson, of the late firm of Lee and Stevenson, 7, Duke-street, Westminster, and form the pumping station of the Rotherham and Kimberworth Water-works.

Two 40-horse power condensing engines, and four 30-horse Cornish boilers, are contained within the main building; and the smaller building is a cottage for the engine-man, the whole being enclosed within a palisade fence.

The buildings are faced with pressed bricks set in ash mortar, and the stone dressings are from quarries in the neighbourhood. The internal dimensions of the engine-house are 43 feet by 24 feet, and of the boiler-house 46 feet by 31 feet. The shaft is 7 feet in diameter at the bottom, and 6 feet 6 in. at the top, and 165 feet high. A winding staircase in the tower gives access to the packing stage and spring beam floors.

The water for these works (at present insufficient in quantity) is obtained from springs in the sandstone rock within the town of Rotherham, and conveyed by gravitation into an arched retaining tank holding 200,000 gallons, at the back of the boiler house. From thence it is raised by the engines before mentioned into two covered service reservoirs at a height of more than 300 feet above the pumping station.

The engines, boilers, &c., were manufactured by the Kirkstall Forge Company at a cost of between 4000*l.* and 5000*l.* The pipes, several miles in length, were supplied by Mr. Barrow, of Staveley; and the buildings costing nearly 4000*l.* were erected by Mr. Freeman, of Ely.

SHAMS AND COUNTERFEITS.

There has of late been a great deal of unnecessarily vehement declamation against the sin—for we are given to understand that it is nothing less—of substituting artificial materials for natural ones, or making use of any other deceptions, which it might surely be sufficiently discredited as paltry and brummagem trumpery (*tromperie*), if such they happened to be, without being put indiscriminately into the same category with "lies," "frauds," "impositions," and even "forgeries." In their over-boiling zeal, the sticklers for the observance of "truthfulness" make—at any rate speak as if they made, no distinction between widely different species of deception,—the positively injurious, and the innoxious. If a person is imposed upon by taking a forged bank-note, he is injured also; but in mistaking stucco for stone, bronzed iron, or it may be lead, for veritable bronze, and grained doors and other woodwork painted so as to imitate any of the rarer and costlier woods, he suffers no other harm than that of being cheated perhaps out of a little admiration, and if so, experiencing no particularly disagreeable feeling. In fact, there is no small degree of laxity in the apparently tight-laced morality which, making no distinction between harmless and fraudulent deceptions, becomes itself a deceiver by juggling with names and words. It keeps most important differences completely out of sight. Inasmuch, for instance, as it is not truth, fiction may be called falsehood, yet no one in his senses would class it with lying. They who, if they are not themselves *shamming* all the while, consider—and they certainly speak as if they did so—all deceptions to be alike immoral, must have very confused notions of right and wrong. If, as they would fain make us believe, the graining of doors and wainscot—(and why not veneering also?)—is as bad as passing off base coin for genuine, the converse holds good, and the latter species of imposition is not at all worse than the other, although society is, and we hope will continue to be, of a dissentient opinion.

Even admitting that there is something paltry in the employment of sham materials, at any rate no moral law is violated, no positive harm inflicted on any one. On the contrary, if the work itself, whatever it be, is in bad taste, it is more satisfactory than otherwise that it *is* executed in perishable materials; and that at any rate, precious material has not been mis-employed by (for so long as it lasts) perpetuating and giving a sort of prestige to paltry design, which last we take to be the paltriness most of all to be deprecated. In fact, those who declaim so furiously against "sham," are no better than *materialists* in architecture. They judge of it as bibliomaniacs do of books, which they appraise not according to their intrinsic literary value or interest, but for width of margin, quality of paper, and other typographical merits, sometimes also on account of some solemn typographical blunder. Material value and æsthetic or artistic value are two different matters: that our satisfaction is enhanced when we find them combined together—both excellence of material and beauty of design, is not to be denied; yet the latter is independent of the worth of the other. Because design constitutes all that an artist can properly lay any claim to as his own—his ideas, his imagination, his taste; such at least is the case with the architect, who, unlike the painter, does not execute his work with his own hands, and whose share in them is the same whether they be executed in stucco or in stone, in scagliola or in marble.

The attaching undue importance to mere material, tends in no small degree to cause comparatively little account to be taken of artistic design, and either its merits to be overlooked or else its worthlessness excused; and is consequently ill-calculated to refine æsthetic feeling. There is, besides, a wide difference between counterfeit and counterfeit: it may be poor and paltry, or even admirable for truthfulness of imitation when known to be counterfeit. There is surely an infinitely greater degree of the mental faculty required for successfully imitating the appearance of variegated marbles and beautifully-veined woods, than for hewing, shaping out, and polishing them. In the latter case, the operative is little more than a mere machine; his work is the labour of the hand alone, accompanied by what is literally "the sweat of his brow." Not so the other: he has to exercise his mind as well as his hand; and almost might claim the grade of a non-commissioned officer in the ranks of art, where he might be allowed to stand next to the painters of still-life. Nevertheless, Mr. Ruskin especially commisserates the unlucky wight who is doomed to work day after day in the unintellectual occupation of graining doors, window shutters, or other wainscot work; yet he does not so much as affect to feel any pity for the comparatively mere drudges in ordinary house painting, who are to be classed not with "skilled workmen," but as mere whitewashers, however far from white the colour they make use of.

Not the least extraordinary among Ruskin's notions and fancies is that if imitation is to be tolerated at all, the clumsier and more bungling it is, the better, because in proportion as it is so the deception is the less. No doubt; but then, what is intended to please the eye would only disgust it. The effect would be no other than that of downright paltriness, and would hardly tend to the improvement of taste. We, on the contrary, hold that the more deceptive imitation is, the more venial is it also, and is capable of affording just as much æsthetic gratification to the mere beholder as he would derive from looking at the same objects, though of different and superior quality in regard to material. Where counterfeit is made—as it is capable of being—to produce artistic effect, the stigmatising it as trumpery argues no very great relish for what is the better part of art. Though only in such a cheap and fragile material as plaster, well-executed casts are facsimiles of their originals; and though produced by the merest mechanical process, are, if from excellent originals, far worthier than autograph yet inferior productions of the sculptor's chisel. Yet, cast metal-work and machine-wrought carving have been not only deprecated but passionately denounced by Mr. Ruskin, who seems to think that the means by which a work of art is produced were chiefly to be considered. Whether he turns up his nose at the Queen's portraits in gold issued from the Mint, because they are stamped by machinery, he has not thought proper to inform us.

If it be desirable that a taste for art and a feeling for the beautiful should be diffused among us as widely as possible—an opinion that is now gaining ground—we ought to look upon it rather as an advantage than the contrary, that modern inventions, and less laborious and expensive processes of production, enable us to indulge such taste on easier terms than would else be possible. To say the truth, we are somewhat at a loss to understand those who attach paramount importance to material, and to the means and modes of production. Is there anything so particularly agreeable in the idea of toil, that we ought to esteem hand-work for the sake of it? Are the stalactite domes and ceilings of the Alhambra and other Saracenic structures the less delightful to the eye, because they consist of nothing more than a wood-work framing filled-in with stucco?

More candid than those to whom we ourselves are opposed, we do not attempt to conceal that something may be argued on the other side of the question; therefore frankly admit that there is

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some danger of the increased facilities of decoration being abused, by being made to minister to vulgar ostentation and tasteless showiness. In proportion, however, as the principles of correct taste become better understood, will the danger diminish. Then trumpery design and tawdriness will be voted *mauvais ton*, just the same as it is in dress. Those who affect superior taste will endeavour to show it by studied elegance of design; which is quite irrespective of the value of the medium or material in which it is embodied. Nor will any one be so hardy as to maintain the contrary, for in representation, whether it be upon paper or canvas, a building shows the same, be it of stone or of stucco; or in the case of an interior, it makes no difference whether what look like coloured marbles be really such or mere imitations of them. As far as general polychromatic effect—which depends so much on the choice and judicious arrangement of colours—is concerned, it is the same (either for good or bad) whether it be natural or artificial.

Do not let us be misunderstood: by no means do we pretend to say that it is a matter of perfect indifference what the materials employed are. In public edifices and all monumental works, it is not enough that they satisfy by nobleness of appearance, or whatever else may be their merits that address themselves immediately to the eye, for we further demand some assurance of the solidity of their construction, and the time-defying durability of their materials. So is it likewise with regard to all structures of architectural importance—let us add, beauty also—although they may be only private property.—And well would it be if permanency of material could invariably ensure design deserving to be perpetuated by it. But what, if judged of merely by its name, is superior as well as legitimate material, does not always prove the most lasting. To say of a building that is of stone, of course sounds well, perhaps in some degree *imposingly* also, for the various kinds of stone differ greatly as to quality, and some of them are apt to decay rather quickly and exhibit symptoms of rottenness, whereas there is artificial stone—call it "composition," if you like, and therefore *imposition*—that is all but indestructible.

By all means, say we, let us make use of the best materials, without regard to expense, wherever it can be done; but do not let us decry as mere trumpery, sham, deception, and paltry counterfeit, the exhibition of really good design be it embodied in whatever substance it may. If the substance itself be perishable, so much the worse; in such case we cannot say, "a thing of beauty lasts for ever," still, so long as it endures, its beauty—at any rate, the beauty of the idea, exists. In its time-honoured and all but ever-enduring monuments, architecture shows us its fixed stars, and it can emit also brilliant though brief corruscations of artistic luminousness. Its permanent achievements are to be honoured; nor, if they possess any æsthetic worth in themselves, are its comparatively fugitive and transient productions to be accounted accordingly as paltry also; for were they even to fade from our sight while we gazed upon them, they would only all the more partake of the nature of the glorious rainbow.

ON THE APPLICATION OF NATURAL FOLIAGE TO ARCHITECTURE.

By James K. Colling.

[*Read at the Architectural Museum, June* 23, 1856.]

In a popular French work on mediæval architecture, the author says, rather quaintly, in his introduction, that "there are people who have good eyes, but who, however, are not able to see that which exists immediately around them, because they have not thought of or regarded attentively that which is before their eyes. We find men to whom all forms are alike, and who are not able to distinguish that which is beautiful from that which is ugly." He further goes on to say, that "such persons are imperfect; they have not developed the faculties which have been given them by nature;" and further, he compares them "to musical instruments which are deficient of some of their strings." When I last had the pleasure of delivering a lecture before you, I endeavoured to point out the same thing, although in other words—this mental blindness and disregard of that which is lovely and beautiful, although it may be lying at our very feet. It is necessary to educate ourselves, to learn to appreciate the beauty of form and the harmony of colour, to learn to separate the beautiful from the ugly.

That we are not yet so educated and enlightened, is plain from the very many questionable forms of design which surround us; things which in the streets of this great metropolis meet us at every turn—in our houses, our furniture, and our various manufactures; yet many of these we are satisfied with, and no one appears to attempt any improvement. Look at our stoves, for instance, and most of the ordinary things formed in cast-iron and intended to be "*highly ornamental*," often described to be of "*elegant and chaste design*" of *superior character*. Perhaps it is a cast-iron hunting-whip, with an accompaniment of foxes' heads, with the lash stiffened into loops to hold umbrellas; for this is an example of the wretchedly tame and worthless things we see turned out of the manufacturers' hands every day under the name of new designs; and it would be a very simple and easy task to point out hundreds of others of a similar description. But such is not my purpose; I would turn to a more instructive task. I would ask you to accompany me, and let us together endeavour to supply in ourselves some of those strings, of which the French author spoke, that are deficient in us. Let us go heartily to work to cultivate that love and appreciation of the beautiful, the true, and the good, which God has implanted in our bosoms; so that we become better and wiser, and that our eyes may be opened that we may shun that which is bad and false.

In my former lecture I pointed out the necessity of closely studying natural foliage, if you are at all desirous to put that life and beauty into your work, that freshness and vigour, which is the main cause why we see so much to admire in the sculpture and architectural decoration of every age, whether it be Egyptian, Assyrian, Greek, Moorish, or Gothic. No matter how rudely sculptured it may be, there is an indescribable something that stamps it as a successful application from nature,—no literal and minutely servile copy of mere natural forms, but a judicious adaptation to the purposes required.

In the present lecture I propose to treat more distinctly upon the application of natural foliage for decorative purposes, and I would here premise, that it is a difficult matter to lay down rules to say how far nature shall be adhered to, or how far it shall be departed from; this must after all, in a great measure, be left to the skill and fancy of the designer. Literal imitations of nature, although ever so beautiful in themselves, will never constitute architectural ornament. Nature must be followed as a guide, a principle; and wherever her laws are infringed, the work will become unnatural; and what is unnatural must be, more or less, ugliness.

In modern ornamentation, the main idea appears to be to give as much as possible for the money; no matter how bad it is, if but the quantity make up for the quality. Our chairs, sofas, sideboards, and looking-glasses are covered up with coarse-looking, badly-carved Louis Quatorze scrolls, all bolstering up one against another as if for mutual support. In this style, too, there is a simple law of nature which is constantly violated; that is, nearly every scroll is growing two ways—it is growing out at both ends at the same time. This is a fault which is carried to an excess in this style, and in the carvings upon our modern furniture; but it is also more or less common to all the classical styles; it exists in the Anthemion ornament, and I am of opinion that it is the great fault in the Ionic volute. Mr. Ruskin has been most severe in the condemnation of this Order, but with what justice I am unable to say: there is, however, something about the capital which always struck me as being stiff and unnatural. The two spirals of the volute both grow from the centre; one, as it were, grows out of the other, and gives the capital a remarkably stiff and unnatural appearance. Now, the Roman architects appear to have seen this defect, and often obviated it by discontinuing the volute across the front of the capital, but made them spring from behind the enriched moulding which comes immediately below the volutes, and placed a flower in the centre. This arrangement is also seen in the Composite, which is taken from the Ionic.

There may be cases where it would be judicious, to some small extent, to break this rule and make the foliage grow two ways; but there cannot be a doubt that where it is carried to excess it leads to nothing but a style which is full of fantastic whims, but soon sinks into unmeaning tameness and insipidity; while those styles which adhere to nature's laws are ever fresh and beautiful. The Gothic styles are entirely free from this fault: I do not remember myself a single example but where the natural law is followed. But you may say, "How is it that the architects from whom we get the Louis XIV. or our picture-frame style—how is

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is that they did not see that what they were designing was not natural?" Because their ideas were based entirely upon former styles, and they lost sight of the necessity of adhering to nature. They thought their conceits were far before nature, and they worked entirely according to whim and fashion. Hence the necessity for constantly studying and referring to nature, that we may at least be *aware* when we are infringing her rules. It is therefore highly necessary that we should all understand the simple rudiments of botany. For a book of reference upon this subject, I cannot do better than recommend to you, as I did in my last lecture, Lindley's School Botany, as it is a most excellent work and extremely moderate in price. Botany, as a science, is rather an abstruse one; but a sufficient knowledge may easily be obtained by the carver or decorator without a vast amount of study, and it will be quite sufficient for his purpose if he merely studies the various classes from their English names. To a person not versed in Latin, unfortunately, the science is involved in a great deal of mystery by the difficulty of retaining names which are formed upon the Latin language.

It is extremely necessary to study the various kinds of leaves and flowers, with the manner in which branches and leaves grow in different species. I will here go through some of the most prominent varieties, with their manner of growing, trusting you will take it up and pursue the matter further at your leisure.

Most plants and trees grow either with leaves and branches alternate or opposite; that is, they are alternate when they spring out alternately at different places on the stem, not opposite each other, as the ivy, oak, thorn, and the greatest number of plants and trees. They are said to be opposite when they spring off from the same point upon the stem in pairs, each leaf being opposite the other, and when seen upon the top, the branch presents a cruciform arrangement, as in the lilac, maple, nettles, and many other plants. Another mode is that of growing in a whorl; that is, more than two leaves growing out from the same point upon the stem. The wood anemone, for instance, grows with the leaves issuing triangularly, and when seen from the top, with its triple leaves and six-petalled flower, presents a most interesting example and a very elegant suggestion for coloured decoration. In Gothic architecture this arrangement was common, and was a favourite and very natural one for the foliage in trefoils. Crosswort has four leaves in a whorl, and goose-grass and woodruff eight. The grasses and other plants of that class grow with the leaves issuing from knots and sheathing the stem. The scrolls of the enriched friezes in Greek and Roman architecture usually issue from sheathed foliage in this manner. The mistletoe grows in a very peculiar way, by forking or dividing into two at every knot, and the branch ending in two leaves which fork in the same manner, the berries issuing from the intersections.

Here, then, we can soon see that a little simple knowledge of botany *may* give us a power of variety in the arrangement of the leaves of foliage which we could not possibly have possessed without this knowledge, when we were proceeding only according to our own fancy or at random, although it may happen that we cannot often take advantage of it, either from the smallness of the composition, or the difficulty of circumstances in the arrangement; but, on the other hand, there may be cases where it would be of the greatest importance, and give to our compositions life and variety they could not otherwise possess.

But perhaps of all studies, that of the various leaves, of which there is an endless variety, embracing the most lovely forms in nature, presents the most important and the most interesting one. There is nothing too minute that is not worth noticing, in the veins, ramification of net-work, crumpling of the surface, and many other matters; for although you are not going to imitate the minutiæ, nature in this respect is always immeasurably superior to every art of man. No matter how powerful the microscope, the more we look into her minute and secret ways, the more perfect only does she become; and it is possible that beauties may be seen under the microscope which would be well worthy of being transferred to our art on a much larger scale. Not that I mean to say you must study with a microscope, but only that I wish to point out by means of this illustration that there is nothing in nature which is too insignificant for study; and however small and unimportant to the eye, it may still conceal a beauty which would be immeasurably valuable to you in your art.

Leaves are, of course, divided into different classes or kinds. First, there is the simple undivided leaf without distinct lobes, which although so simple still contains a great variety of forms. They are often used with good effect in carving, and some of them, although perfectly simple, are very beautiful. There is an example of their use in old work in a spandril from Southwell, where two different kinds of simple leaves may be seen in the same spandril; also an example of the hazel from Winchester cathedral. Simple leaves are again divided into distinct lobes—as the hepatica and herba-benedicta or water-avens, which are divided into three. The beautiful foliage of the Early English period, the period of the 13th century, was mostly taken from triple leaves, and were no doubt adopted as being emblematical of the Trinity. The ivy, vine, maple, and many others, are divided into five lobes—in the maple each lobe is again cut into three or more parts, and in the vine each lobe is serrated, that is cut like the teeth of a saw, as is the case with many of the more simple leaves—as the Spanish chestnut, elm, and many others. The thorn, which is a valuable leaf to the carver, is sometimes divided only into three lobes, but more often into five, but sometimes as many as seven and even nine. The thorn was deservedly a great favourite among the artists of the 14th century, and they have left us many beautiful specimens of their manner of treating it—both in flower and in berry. There are several excellent examples of this in the Museum, from the charming little chapter-house at Southwell minster, also some from the continent. It was also the type of much of the foliage which was used at a later period, as at the chapter house at Ely, but which became far more conventional and less like the natural type. There are also beautiful examples of the use of the ivy, maple, vine, and other five-lobed leaves, from Southwell and other places.

But to return to the different kinds of natural leaves. The oak leaf is irregular in the number of its lobes, sometimes having more on one side than the other. This is a leaf which has so much distinctive character of its own, and its being usually accompanied by its well-known fruit, the acorn, that it is usually recognised quicker than any other kind of foliage. There is another kind of oak that has a very elegant leaf, which has been introduced into this country of late years—called the Turkey oak. There are several trees of this kind to be found in the Regent's Park. There are other kinds of leaves which have many lobes, as in the thistle and dandelion. I do not remember to have ever found the leaf of the dandelion in old carvings, but it is a very beautiful leaf and one that I think might be used to great advantage. The thistle, from its sharp, bristling crispness was another of the old favourites, and was used even more on the continent than it was in this country.

These are still called simple leaves. A compound leaf consists of several leaves or leaflets as they are then called, on the same stalk, as in the clover, laburnum, and strawberry, each of which consists of three distinct leaflets; also the rose, which has five leaflets and sometimes seven. The horse-chestnut and many others have five or seven leaflets all issuing from one point on the stem, and are termed palmate, or like a hand. The ash, acacia, and others, have the leaflets in pairs on each side of the centre stalk with a single one at the termination. Other leaves are doubly compound, as the parsley, which consists first of a centre stalk from which issue other stalks, and from these again issue leaflets. Many of the fern leaves, most of which are very elegant, are of this kind—that is, doubly compound.

Other leaves are trebly compound, as in double-parsley, carrot, and others; but as these are mostly of too complicated a nature for the use of the carver, we need not pursue the subject further. There are many varieties of the different kinds which I have mentioned, all of which you will find most interesting for the purposes of study. The same plants also will sometimes bear both simple and compound leaves, as in the herba-benedicta, &c.

Another most interesting branch of study is that of flowers, both as regards arrangement and also general form; as a general rule, the forms are more simple than in leaves, but the arrangement is much more various. Flowers may, like leaves, be divided into simple and compound. A simple flower is either entire and undivided, as in bell flowers, or it consists of a certain number of leaves or petals, as they are technically called, usually radiating from a centre. The most simple, except those which are entire, consists of three petals, as the snowdrop. Others are cruciform, of four petals, such as the wall-flower and stock. But by far the most common number is that of five, as in the common primrose, dog-rose, and many others. We see the five petals in the ordinary tudor-rose, which is taken from the common dog-rose. The wood anemone and jonquil have six petals; pilewort and crowfoot, eight. The stickwort or stellaria has five petals, each

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petal being again almost divided into two, giving a star of ten points. The iris, from which the conventional fleur-de-lis is taken, consists of six petals, three of which turn upwards, forming a kind of crown, and three turn very gracefully downwards. The similarity to the conventional form of the fleur-de-lis is plainly seen when one of the petals which turn upwards is brought in the centre. It is a beautiful, symmetrical flower, and offers, I think, a fine suggestion, as no doubt it has often hitherto done, for a very elegant metal finial. It is a very common thing to make metal fleur-de-lis consist only of three parts—two lower leaves and one in the centre, as they are represented in painting or sculpture; but what an improvement it would be if they were made triangular, with all six petals as in the natural type.

The lilies also are of six petals, and are arranged much in the same manner as the wood anemone and jonquil. The lily has been from time immemorial the emblem of purity, and, from its triple combination, it is also a beautiful emblem of the Trinity; it is not surprising therefore to find that it was the type of many of the most beautiful forms in Gothic architecture, as the different varieties of the hexafoil, triple bosses, spandrils, &c.

There are also a vast quantity of flowers which do not radiate from the centre, as the heart's-ease, pea, orchids, and a variety of others—many of them offering beautiful suggestions in form and colour, and opening altogether a field for study which, for decorative purposes, has been comparatively yet untrodden.

Compound flowers consist of a number of small flowers or flowrets, united upon a disk, as in the sun-flower and daisy; or they form a cluster called an umbel, as in parsley; a spike, as in the foxglove and lupin; or they are clustered together in various ways or forms too numerous for me to mention. In applying natural foliage to decorative purposes, the first thing to be laid down is the general lines, that is, the direction and disposition of the stems which are to be afterwards clothed with foliage. Great care should be taken that these are judiciously chosen; they must not too closely follow nature; there must be no broken or rustic foliage, such as we see so often in silversmith's work; there must be a harmony and an agreeable contrast with the bounding or surrounding lines. In architecture, nearly all ornament is obliged to be arranged geometrically, for without it is so, to some degree, it will seldom harmonise happily with the architecture which it is intended to enrich. It may sometimes be departed from to a small extent, to give variety and to gain picturesque effect; but there must be a certain harmony kept up, and the lines of the foliage must not jar or clash with the mouldings or other architectural lines which surround it. For instance, if we take a spandril, which is merely a triangular space left by the architectural lines in canopies and other places, the most simple of all lines to arrange the foliage upon will be three lines issuing from the centre and running to the points of the triangle. These lines are in harmony, because they do not approach too near or in any way jar or interfere with the bounding lines, and they are simply a geometrical division of the triangle into three other triangles. In the same manner, if we require the most simple lines for foliage in a square, we have them immediately in lines proceeding from the centre to each of the angles, which give the ordinary diagonal lines. Next, in the triangle, we have a triangle introduced in the centre. In the square we may introduce a diagonal square, touching the centres of the sides of the larger square. This may be varied by introducing circles in place of the triangle or square; from this we arrive at the scroll in place of the complete circle. Commencing again with our first three lines, we can produce variety by uniting them by curves; further by branching, as in parsley; by leaflets in pairs, as in ash and fern; branching alternately, as in oak; and further, if required, it can be carried to any extent of elaboration and richness by following the manner of subdivision of any of the more compound leaves, as in some of the most beautiful and delicately-divided ferns. Although this subdivision may probably be too elaborate to carry out in stone or wood, yet I can conceive of its opening a beautiful field for decoration in other materials—such, for instance, as diaper for linen fabrics, carpets, gold and silversmith's work, painted decoration, papers for walls, and many other works.

To return to our general lines, it is evident that variety can be gained by introducing scrolls, yet still keeping up all the original arrangement, until at last we arrive at a combination perhaps equal to the beautiful scroll spandril from Stone church, Kent, which perhaps, for the very charming manner in which it is arranged, is as successful as anything which can be met with. Another simple mode of arranging the lines is that of simply radiating from the centre as in flowers: the most simple, being three radiations or two threes, is in the lily, as I have already mentioned. Four, two fours, and so on, as in flowers. Another mode is that of fan radiation, as in the lupin and horse-chestnut. Of this character are many of the Greek honeysuckle ornaments. If the surface is large which is to be covered with foliage, it will be found to be highly advantageous to divide the surface into some pleasing combination of geometrical forms, afterwards filling in the spaces left with foliage. In this manner are some of the most exquisite wall-diapers of the Alhambra. Geometrical combinations have this great advantage—they are all founded on forms in nature; there is no limit to the variety which can be produced, and they do not tire the eye like any confused or irregular arrangement. There is always a certain order and symmetry which is pleasing to the eye.

No better practice can be conceived in the study of decoration than that of making skeleton diagrams of the general lines or stems merely, in the various compositions, both classic and Gothic, which are collected together in this Museum. You will perceive what variety there is, and upon what principles they are laid out, and you will farther put yourself in a position to strike other combinations which have not yet been developed. In this study you should treat everything in the flat; if it be a capital, or a crocket, or a boss, unwrap it and lay it out in the flat, so as to study the first principles independent of the curved surface to which it is afterwards applied. Having well studied the stems or general lines, you will find the next step comparatively easy, that of clothing with leaves and flowers the general lines which you have laid down. Here again you will find that the forms of leaves are intimately connected with geometry,—that they are based either upon the triangle, the square, the pentagon, or the circle, and that often the space to be filled in will suggest the kind of leaf to be used. You have then to study the light and shade, as I more particularly explained in my last lecture, and by following the matter up with a constant reference to nature, and without tying yourself down to copying old examples, looking at them more for the ideas they contain, and for the purpose of comparing them with nature, seeing what their designers took from the great book and what they left, you will soon find that you are enabled to take a more comprehensive view of foliated design than you had ever before imagined, and you will begin to strike out new and independent beauties, which in time cannot fail of producing the happiest results. I feel certain myself that there is a field open to us in ornamental and foliated design of which we have yet no conception, going far beyond anything which has been already done. *I* cannot develope it, and *you* cannot develope it, individually; but it must be the work of an age, the work of all, all working in the right direction. We should thus produce something in art which would yet be a glory and a halo around the setting sun of the 19th century.

KENNEDY'S WATER METERS.

In water supply, as in the supply of gas, it would be equally desirable in all cases to be able accurately to measure and register the quantities, so that each person might be charged for the number of gallons consumed or wasted. The want of some simple instrument, the registration of which could be depended on, has hitherto prevented the general adoption of that plan of charging for the supply of water, and it is only in special circumstances that water meters have been used. The unsatisfactory and wasteful method of giving a time supply has been continued, because the cost of meters and the uncertainty of their action have been considered greater evils than the inconvenience to be remedied. In the supply of gas, indeed, the plan of charging by the quantity and size of the burners was found to be so extremely unequal and unjust, that it became an absolute necessity to contrive some means of measurement; and though the difficulty of measuring the quantity of gas supplied was far greater than that of measuring water, the necessity of the case compelled the contrivance of meters for the purpose. It is true that no gas meter has yet been invented that fully answers the desired object, but imperfect as they are they nevertheless serve as tolerably accurate registers of the quantities consumed, and very few persons who burn gas fail to be provided with such a means of measuring.

Of the water meters that have been invented, Mr. Kennedy's seems to fulfil the required conditions more completely than any

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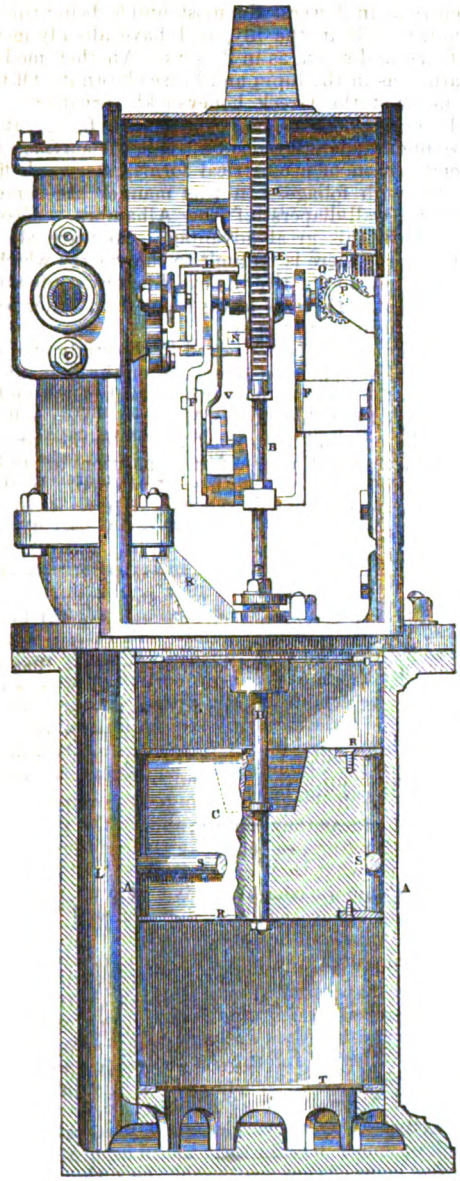


Fig. 1.

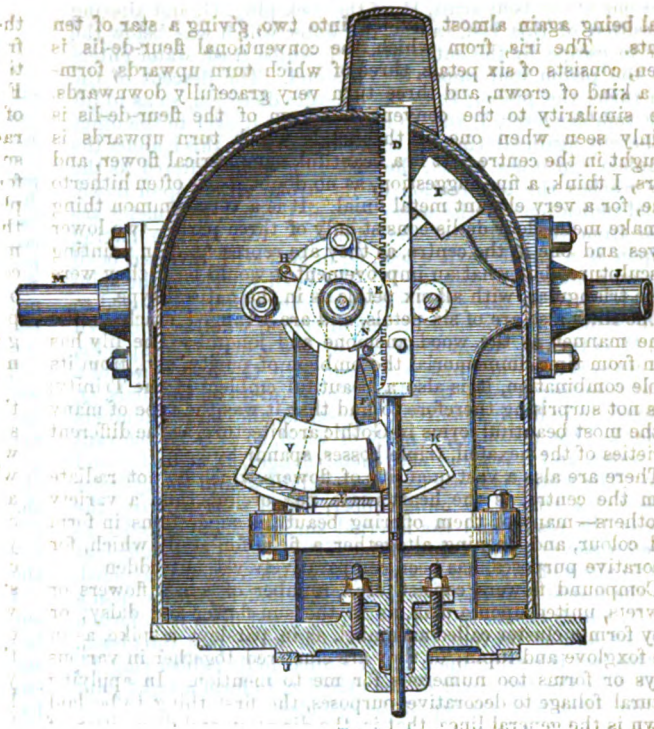
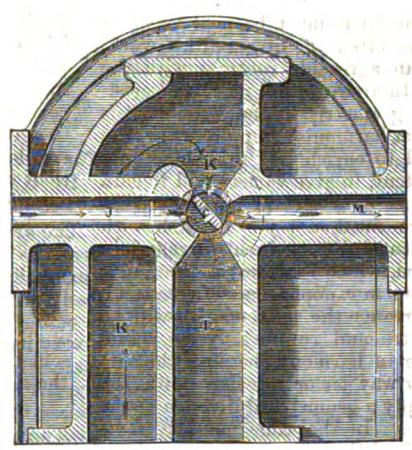


Fig. 2.



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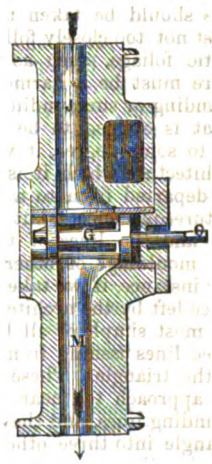

Fig. 4.

other; and though its present cost stands in the way of its general adoption, yet when the importance of being supplied by measure becomes more fully appreciated, that obstacle will be overlooked; and arrangements might be made with the water companies, as is now done with many gas companies, for supplying meters to their customers and charging a rent for their use.

Mr. Kennedy's meter consists essentially of a vertical cylinder, within which there moves a water-tight piston. The contents of the cylinder being known, the quantity of water that passes through the supply pipe at each stroke of the piston can be accurately ascertained by numbering the strokes of the piston; and that is done without much difficulty by means of a rack and pinion with a series of wheels and indicators attached, similar to those of an ordinary gas meter.

The accompanying woodcuts will show more clearly the action of the instrument.

Fig. 1 is a side elevation with the casing removed, to show the internal mechanism, and with the measuring cylinder in vertical section. Fig. 2 is a front elevation of the upper part of the apparatus, but with the counting mechanism and front plate removed to show the details by which the valve or cock is worked. Figs. 3 and 4 are vertical and horizontal sections through the waterways and cock. The main fluid cylinder, A, into which the water is passed, is set vertically on a suitable base, its upper end being covered by a plate, in which is the stuffing-box for the rod, B, of the piston, C, to pass through from the interior of the cylinder The projecting end of this piston-rod has attached to it a rack, D, in gear with a pinion, E, the spindle of which turns in bearings in a bent bracket, F. The rack is kept in gear with the pinion by means of a small antifriction roller carried by the bracket, and between which roller and the pinion the rack passes. The spindle of the pinion, E, is in the same axial line as a fourway-cock, the plug or key, G, of which has upon it a pair of bent lever arms, H, arranged for the weighted tumbler, I, to fall against in either direction. The fluid supply is derived from the pipe, J, communicating with the shell of the fourway-cock, from the two opposite ports of which the passages, K, L, pass down to the upper and lower ends of the cylinder, A, respectively, the passage, K, being curved to one side to clear the inlet passage, J. The fourth passage, M, opposite to the ingress pipe, is the discharge outlet. As delineated in the figure, the piston, C, is supposed to be rising, water entering beneath it, while that which is above it is passing off. As the piston rises it lifts the rack, D, and, turning the pinion, E, causes a catch, N, fixed to the back of this last, to lift up the tumbler lever, I. This tumbler lever is carried loosely on the spindle of the pinion, E, and, as the piston reaches the top of its cylinder, is brought up to its vertical position, and falls over suddenly to the other side. In falling over, the tumbler lever, I,

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strikes one of the bent arms, H, of the cock plug, G, and altering the position of this last, causes the water which was below the piston to escape by the outlet pipe, M, whilst fresh water enters above the piston, and causes it to descend. The descent of the piston turns the pinion, E, in the opposite direction, so as to lift up the tumbler lever, I, and to finally throw it over to the other side, thereby again altering the cock plug. And in this manner the mechanism continues to act, the cock plug being altered as the piston reaches the termination of its stroke either up or down. The dial indications of the water passed through this meter are derived from the spindle of the pinion, E, this spindle having fast upon it a small bevil wheel, O, in gear with reversed bevil wheels on a horizontal spindle, P. The bevil wheels on the spindle, P, are fitted on this spindle with ratchet wheels, arranged so that the spindle always turns in one direction, whether the bevil wheel, O, is turning in one direction or the other. The spindle, P, has upon it a worm which is in gear with the first wheel of a train of counting wheels, by which the pointers on the dials, Q, are moved, to indicate hundreds, thousands, and larger numbers of gallons. The piston, C, is made of wood, so as to be buoyant in the water, and it is fitted with metal flanges, R, at its top and bottom. The piston is made to fit water-tight within the cylinder by means of a ring, S, of india-rubber, which rolls between the surface of the piston and the internal surface of the cylinder as the piston moves up and down, the piston being of a sufficient length to allow of this rolling action, by which friction is avoided. When the piston is at the bottom of the cylinder, it rests upon a flange, T, which has an india-rubber ring fitted upon it to form a tight joint, and so prevent the passage of water past the piston, when this last is resting upon it. A similar india-rubber ring, U, is fitted into the top cover of the cylinder, to form a tight joint when the piston is at the top of the cylinder.

Mr. Kennedy's meter has been practically tested by several engineers, who have pronounced strongly in its favour. Experiments were made with it, in comparison with the meters of Mr. Taylor and of Mr. Siemens, by direction of the water-works committee of the Halifax corporation, and some of the results as announced in the report of Mr. G. W. Stevenson, the engineer of the corporation, deserve to be noticed. The following are extracts from that report, which is dated May 27th, 1856:—

"The tests I adopted were, 1st, as to accuracy of measurement; 2nd, relative quantity delivered; 3rd, relative loss of pressure sustained by the passage of water through the meter.

"The pressure upon the pipes was equal to a head of water about 180 feet high.

"The first test as to accuracy of measurement, was made by filling from the delivery-cock a standard gallon measure one hundred times. At starting, Taylor's meter registered 16 above zero, Siemens' stood at zero, and Kennedy's was 10 below zero; at the conclusion of the first trial the register was as follows:—

Taylor	183	gallons.
Siemens	105	,,
Kennedy	91	,,

Taylor giving 22 per cent. too much, Siemens 5 per cent., and Kennedy 1 per cent.

"On the second trial, after the same manner, the result was—

	Previous register.			
Taylor	260 — 138	=	122,	or 22 per cent. full.
Siemens	204 — 105	=	99,	or 1 per cent. too little.
Kennedy	191 — 91	=	100,	the exact measurement.

"On a third trial, to determine the cause of the variation in Siemens' meter, the register when taken was, for—

	Previously.			
Taylor	386 — 260	=	126,	or 26 per cent. too much.
Siemens	304 — 204	=	100,	the exact measurement.
Kennedy	291 — 191	=	100,	also ,, ,,

"The second test, made with the same meters, was as to the relative quantity of water delivered through meters of the same size, and was made in the following manner:—Inlet and outlet pipes, 1 inch in diameter, were connected from the 2-inch main before mentioned to each meter, and supplied through a 2-inch sluice cock; the water was allowed to run through them for exactly fifteen minutes, when the register was—

	Register at starting.		
Taylor	1264 — 687	=	577
Siemens	1112 — 600	=	512
Kennedy	1610 — 575	=	1035

"The third test, was to ascertain the relative loss of pressure sustained by the passage of water through the meters. To do this, I placed a ¼-inch nib upon each outlet, and played with vertical jets against a measured surface.

Taylor's meter delivered 35 feet high.
Siemens' ,, ,, 40 ,, ,,
Kennedy's ,, ,, 45 ,, ,,

"I then disconnected the meters, and played through the ¼-inch nib, as before, against the same surface, when the three jets delivered as nearly as possible (neither more nor less) to the same height as through Kennedy's meter.

"The result of the tests I adopted (and they are as severe as it is possible to use) were, as you will have seen, decidedly in favour of Mr. Kennedy's meter. It registers with almost perfect accuracy, delivers twice the quantity of water, size for size, as either of the others, and occasions no perceptible diminution of pressure in the supply. The price, also, is really less *pro rata* than that asked for either Taylor's or Siemens'; Taylor's being 5*l.* per inch, Siemens' a little more, and Kennedy's about 8 guineas. The capacity for supply, however, ought to regulate the price, not the diameters of the inlet and outlet pipes, which is only a nominal, and therefore a fictitious distinction."

To ensure the general adoption of these meters in ordinary water supply to the inhabitants of towns, it would be most desirable that the price should be reduced to the lowest remunerative scale. The smallest size at present made costs five guineas, but a meter of that size is stated to be capable of discharging 500 gallons an hour. A much smaller quantity than that would be sufficient for general use, and a meter capable of discharging one-tenth part of the quantity might be manufactured at considerably less cost, so as to make the employment of the water meter general.

Independently of the use of such a meter in ordinary water supply, for which it was intended, a new application of it has been suggested by Mr. Brunel. He proposes that a water meter should be placed between the feed pumps and boilers of marine engines, so as to indicate the exact quantity of water evaporated by every boiler. By this means the proportion of work done by each boiler may be ascertained. Mr. Brunel has determined to adopt that plan in the leviathian ship now building at Blackwall. It has accordingly been fitted up with twenty of Mr. Kennedy's meters for the purpose of obtaining this additional indication of the working condition of the boilers.

REVIEWS

The Churches of Essex architecturally described and illustrated By GEORGE BUCKLER, Architect. London: Bell and Daldy [Second Notice.]

The second and third numbers of this publication do but confirm the opinion we expressed after examining the first. The illustrations are wretchedly scanty, indifferently selected, and carelessly drawn in a sort of skeleton diagram only. The letter-press is better, and a great deal of information is really condensed into a very narrow compass; the labour expended in collecting these materials must have been something considerable, particularly in the historical notes, which are carried back to a remote period: indeed the book promises to be far more useful in an archæological than architectural point of view. Although the author states truly that many choice specimens are to be met with in the county, for our own part we never esteemed Essex a peculiarly valuable district for study, since the majority of the buildings are unquestionably rude and poor. Still there are varieties to be found in all the styles of architecture, including the Saxon of Trinity Church, Colchester; the Norman of Castle Hedingham, St. Botolph's Priory, Colchester, and Waltham Abbey; the round towers on the northern boundary; the early English of Beeleigh Abbey, and a host of small churches; the Decorated work at Witham, Waltham, Tiltey; or the Perpendicular of Thaxted, Dunmow, Chelmsford, &c. Again, the thick rough-built walls such as at Copford; the shingle spires of Braintree, Burstead, and elsewhere; and the pattern flint-work at Great Bromley, Dedham, St. John's Gate, Colchester, and many other places. These have been partially illustrated already, but there is abundance left for Mr. Buckler, if he will only make choice of really useful examples, and exhibit them in fitting style. Instead of this, we find the "Perpendicular font" of South Ockendon described as "elegant," whose geometrical design appears commonplace and unprepossessing. Fryerning church, too, shown in rough outline, has an exceedingly curious brick tower deserving more explicit rendering, since in this part of England the use of red brick seems to have been very prevalent in the construction of Gothic details of the declining period. See also the curious porch at Feering, the famous Rye House, and some baronial halls of Suffolk.

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Besides South Ockendon and Fryerning, these two Parts give descriptions of Mucking (really devoid of interest), and Shenfield, an early structure whose walls are a yard in thickness, and whose wooden steeple is very curiously constructed upon four large arches in the same material, upon which traces of colour are perceptible. There is also a fragment of the original wall-plate in the church which is carved with a dog-tooth ornament in the hollow. The next church treated of is Hadleigh, which consists simply of nave and chancel, the latter having a semicircular end, as at Pentlow and Copford. The chancel arch is in three openings, of Norman design, quite plain. This arrangement appears to have been by no means uncommon in the "remote churches of Essex." The belfry is of timber, as is also that of Mountnessing, where it terminates a west front, of curious if not beautiful design. It is in brick, remarkable for its seven buttresses on the face, which bears date 1653. The proportions and plan of this church are most extraordinary, but it would seem to be in reality only a part of *the* ancient building.

The churches already described are not in one locality, but lie scattered; and one is rather at a loss to comprehend on what plan the book is being compiled, and what peculiar claims the author can allege for these being brought thus prominently into notice. But time may show.

Examples of Antient Domestic Architecture. By FRANCIS T. DOLLMAN. Imperial and royal 4to. London: Bell and Daldy. 1856.

We have before us the first part of this work, by the author of "Examples of Antient Pulpits," (who, we believe, was a pupil of the elder Pugin), illustrating the schools, almshouses, bede-houses, and hospitals of the middle ages in England, and is we think extremely apropos, at a time when buildings of this class are so rapidly springing up in every part of the country. The first part contains ten plates, and the entire work will have forty illustrations, elucidated by historical and descriptive letter-press. The subjects of the present illustrations are St. John's Hospital, Northampton, and the beautiful half-timbered example of Ford's Hospital at Coventry. The two examples given are most valuable and interesting ones, and a comparison of the arrangement of the two buildings, differing as they do in many essential points, deserves very careful consideration. Mr. Dollman's object appears to be that of rendering his work a practically useful, rather than merely a pictorial one, although perspective views will occasionally be introduced. If the book is completed in the spirit it has commenced, it cannot fail to prove of essential service to the professional man and the amateur, as the plans, elevations, and details (the latter more especially), are most carefully delineated.

The plates have been entrusted to Mr. J. R. Jobbins, who has in every respect done justice to Mr. Dollman's drawings, by imparting to them that clearness, effect, and delicacy which they demanded.

We understand the second part, now in progress, will contain the invaluable example of St. Cross' Hospital, near Winchester; and the smaller, but curious and interesting Hospital of St. Mary, at Chichester, which, we believe, has never been published.

We trust that so useful a work will meet with proper encouragement from the architectural profession, who are really indebted to the author for his attempt to concentrate properly in one volume a series of such valuable subjects, many of which, though centuries old, in every point of view show how far in advance of the modern school were the architects of the wrongly called *dark ages.*

Earthwork Table to calculate quantities for all Lengths, Bases, and Slopes. By JOSEPH LOUIS GALLOTT. Dublin: Hodges and Smith. 1855. (Lithographed Sheet).

The title of this table is somewhat too comprehensive, for the table only extends to those cases in which the cutting is of the same depth on both sides of the railway, and the upper line of the cross section of the cutting is consequently horizontal. The more difficult case in which the cutting is made on the side of a hill, the case of "sidelong ground," is not treated of by Mr. Gallott.

In the different methods which have been adopted for computing contents of earthwork, the principal variety has consisted in the mode in which the cross section of the cutting is divided into parts, each of which is the base of a solid of which the content is to be separately computed. The cross section is, of course, a trapezium, and in level-lying ground two of the boundary lines are parallel, namely, the horizontal line just spoken of, and the level of the railway; the remaining two lines are those which indicate the slopes. Mr. Gallott divides this trapezium by vertical lines drawn upward from the base of the slopes into three parts, a rectangle and two triangles. The solids which have the two latter for bases are alone computed by this table. The remaining solid, *i. e.* the whole mass vertically above the railway, is left to be computed by the engineer, by multiplying the mean depth of the cutting by its length, and reducing the result from cubic feet to cubic yards. In the short explanation of the table, we observe, besides an error in grammar ("in column 1 *is* entered the respective heights"), another mistake respecting which those who use the table ought to be warned. "H + *h*" is no less than four times misprinted "H × *h*."

The table itself is well printed and distinct, and is arranged in a manner convenient for reference. The mode of computation of the figures is not stated, and of course we must rely on the author's authority for their accuracy.

In the eleventh volume of this *Journal*, we published tables for computing the contents of earthworks both in level-lying and sidelong ground. The method there adopted of dividing the cross section for the purposes of computation we believed to be the most convenient, and this opinion continues unaltered after examination of numerous tables for similar purposes, which have since been published.

In Mr. Gallott's tables, the numbers are given for *every foot* of depth of the cutting from 1 to 70 feet. When the cutting is not deep, this mode gives results sufficiently close; but for higher figures the intervals of tabulation ought not to exceed half feet. Thus in Mr. Gallott's table the number corresponding to [60, 60] and [60, 61] differ by 223. Consequently, when the cutting is about 60 feet deep and the slope 2½ to 1, a difference of a foot in the height would give an error in the tabular quantities of 557 cubic yards for every 100 feet length of cutting. It is clear that, therefore, in a long cutting, a difference of half a foot in the depth of the cutting makes a serious difference in the content required.

Some serious observations and suggestions upon the defective plan of Sewerage proposed by the Metropolitan Board of Works, together with a method for remedying the evil. By G. R. BOOTH, C.E. London: W. E. Painter. 1856.

This is a curious *brochure*, of which just one half is occupied with preliminary statements of what everybody knows, and the other with mysterious hintings which no one can divine. To the enquirer for further information, the author does not say "read my book," but "come and consult me," adding "this we do for self protection; but this will not hinder us from being useful to the public, until the time may arrive when we can feel justified in disclosing our method and plans."

It may suffice for the present to observe that the author neither wants a manufacturing establishment for the production of the article he proposes, nor a manufacturing process to which the sewerage shall be subjected.

He "would direct especial attention" to two manifest mistakes made in the plans and proposals which are at present under the consideration of the Metropolitan Board of Works. First, why has not the immense tidal power afforded by the Thames been employed to supply the lifting power demanded at Plumstead and elsewhere, instead of applying heavy steam power for that purpose at an immense outlay, and at a constant and recurring heavy charge? Secondly, why does not the design carry the sewerage of London to the salt water, from whence it could never return up the river?—Perhaps the enormous expenses which these would entail is a sufficient answer to both these questions.

In emendation of the present scheme, the author proposes to apply the sewers as they now stand, to serve the purpose of new ones; and considering the objects in contemplation, to carry out together both the storm water and the common sewerage matter. The existing sewers would thus be divided into high-level sewers, low-level sewers, and storm-water sewers. The way in which all these are to operate is not very clearly explained, but "a diagram may be seen by application to the writer;" and whence the immense "saving to the pockets" is to be derived when works of such complexity and magnitude are suggested, is equally indefinite, although we are told that it does not involve the expensive (!)

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construction of miles upon miles of sewers; an assertion which to us seems scarcely reconcilable with what is elsewhere stated. But "any one having the slightest pretensions to genius, ingenuity, or skill, may readily carry out the details. All that is wanted is an elementary knowledge of the matter, and the mode of applying the materials to render the sewerage of the metropolis the most excellent and productive manure in the world."

The Handbook to the Metropolitan and District Board of Works. London: Abbott, Barton, and Co., Upper Wellington-street, Strand. 1856.

In a very compact space we have here a summary of the results of the late sanitary enactments, classified in a useful manner, and affording a vast amount of statistical information also; the whole compiled, as the preface assures us, from official sources, which will cause it to be accepted as an accurate book of reference.

Its contents embrace the preamble and heads of sections of the Act, the constitution of the several district Boards, with their officers, and a list of the commissioners of sewers. Then follows a full list of the members of the thirty-six metropolitan Boards, another of district surveyors; a description of the plan of the London sewers (noting the course which each traverses), and a table of the amounts expended by the sewerage commission during six years; a guide to the water and gas companies; a list of the commissioners of public buildings; and the returns of the census;—altogether a handy handbook, well worth the cost of purchase, which is only a shilling.

Report of the Committee of Inquiry into the Appropriation of the site of Smithfield, and the Establishnent of a New Metropolitan Meat Market. London: Spottiswoode. 1856.

The site now called West Smithfield consists of about 4½ acres, in the centre of the metropolis, and forms portion of that field which was granted in 1638, by King Charles the First to the Corporation of the City of London for the purpose of holding fairs and markets. The purpose for which the land was granted having ceased, and the Corporation having removed the cattle market in accordance with the provisions of the Act of 1850, a committee was appointed to report whether the land should revert to its previous uses, or whether some new and better appropriation of it can be made.

The committee have now made their report to the Houses of Parliament, after having examined several witnesses interested in the matter. The Markets Improvement Committee proposed that the open space should be covered over by buildings erected to receive the business of Newgate Market, and they think this a proper opportunity for removing the meat market.

Three plans prepared by the city architect, Mr Bunning, were produced. The committee are of opinion that as the present site of Smithfield is too small for the erection of a market building of more than one-third, or one-half, of the extent of the buildings now occupied in and about Newgate Market, it is impossible that the whole business should be transferred to such a building; and it could not become a substitute for the existing market, even if it should become an appendage to it. The subject of a new metropolitan dead meat market has been considered, and nearly all the witnesses were in favour of one central market in preference to several distinct markets, and the committee have come to the same conclusion:

"The trade in meat is conducted through the medium of commission salesmen, by whom we were assured that it would be impracticable to ascertain the proportion between the supply and the demand, except in a single central market. Competition alone can rule the price of an article of prime necessity; and competition is most effectually attained in one market. The different classes of consumers can also be more readily supplied with what they require, where the choice is most abundant; and the humbler classes especially have more facilities for obtaining wholesome, though inferior, meat in a great market than in one of limited extent. The experiment of establishing markets in different parts of the metropolis has been frequently tried. A great number of small markets which existed in London some years ago have been entirely closed. The few which still remain open, Whitechapel, Clare, and Portland, and other markets, are in a languishing state, and the trade shows a decided determination to a single central market. The most remarkable proof of this is to be found in the fact that St. George's market, south of the river, the district from which by far the largest proportion of the demand for meat arises, has been of late almost abandoned."

The committee recommend that the existing site of Smithfield should be kept free from buildings, and the space adapted for the recreation and enjoyment of the public, surrounded with trees; that a new metropolitan market for the sale of meat should be established, and that such market should be placed in a central position, in preference to a market at Copenhagen Fields, which is too suburban and removed from the principal sources of demand.

OTTO AHLSTROM'S PATENT EXPANSION SCREW BOLT AND NUT.

THE accompanying engravings represent improvements in fastenings, to be used as a lewis for lifting purposes, for fastenings in masonry, or to rock under water, without hammering or using lead. Also, for fastening in iron without tapping and without a head passing through, in holes just as they were cast, forged, or drilled.

A bolt is made with a wedge-shaped end, having a pair of semi-cylindrical collars, cut to the same angle as the wedge and sliding upon it. An open steel ring or spring keeps them together. The bolt-head and collars are inserted in a hole (in which they may work very free or loosely); the upper part of the collar is flush with the mouth of the hole; the article to be fastened is placed on the bolt against these; by screwing down the nut the wedge-head is drawn up between them, and causes them to expand until they fit tightly in the hole, after which no strain can draw the bolt out without crushing or tearing the material.

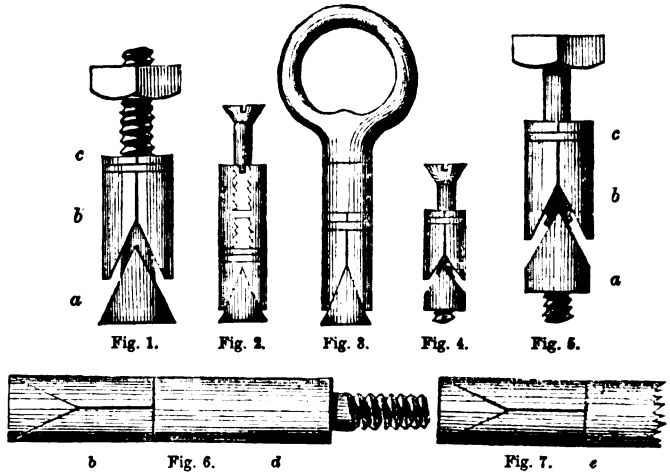

Fig. 1, is the simplest form of the expansion bolt; *a*, is the wedge-shaped end, its point, or rather points, extending up on either side of the bolt; *b b*, are semi-cylindrical collars, cut at their lower ends to the same angle as the end of the bolt; *c*, is an open steel-ring or spring, lying in a groove, and serving to keep the collars together, and on the bolt.

Fig. 2, is a sectional view of a bolt and nut, sometimes required for fastening in brickwork by passing through the plaster of finished walls; the wedge and collars are similar to those of fig. 1; but there is a long cylindrical nut fitted to them, with a cut or groove for the screw-driver in its upper end. Its lower end is screwed on the bolt, and against collars *b b* (until expanded so as to be firm in the hole), when, by the ordinary countersunk-head screw, the article may be fastened, or ornamental knobs or hooks may be used, and readily removed, while painting or cleaning, without injuring the walls; the nut being flush with the wall, is not in the way.

Fig. 3, is a bolt similar to fig. 1, but has, instead of the square nut, one in the shape of a ring or handle, and is intended to be used as a lewis for raising heavy blocks of stone or metal. It can be attached and detached in a moment, and only a single round hole is required to fasten in. A tube or cylinder is fitted between the collars and the nut, or handle, to give additional length.

Fig. 4, is a common screw-bolt with countersunk head; the wedge is a nut, answering the purpose of the wedge-end *a*, in fig. 1.

Fig. 5, is similar to fig. 4, except having a square-headed bolt.

Fig. 6, is a large bolt, the collars, *b b*, having no groove or ring *c*, as the others.

Fig. 7, is a similar bolt, with a dove-tailed ear on each collar, by means of which they are attached to the tube or cylinder, *d*.

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BRIDGES AND VIADUCTS OF THE PRESENT DAY.

By JOHN CLAYTON.

[*Paper read at the Royal Institute of British Architects, May* 19.]

THERE are few public works (commercially speaking at least) of greater interest or importance than bridges and viaducts. The necessity of good roads of communication from one part of a country to another, and the impossibility of completing them without erecting bridges over streams and viaducts over valleys, have given rise not only to the works of the present day, but also to those stupendous monuments of antiquity which have been handed down to us. With the magnificent bridges, viaducts, and aqueducts of the Romans every architect must be well acquainted, and it is indeed not long since that ancient Roman roads and modern British railways were compared by a very able authority before this Institute. In consequence of the immense extension of the railway system during the last thirty years, a more extensive field of bridge building has been opened than at any previous period. The fact that in 1852, 15,000 miles of railway had been constructed in Great Britain alone, and that these required, on an average, three or four bridges per mile, will give a total of 50,000 bridges, large and small.

In speaking of the bridges and viaducts of the present day, it will be hardly necessary to observe that their great and striking peculiarity is to be found in the use of iron; and though, as architects, we may be impressed with the superior dignity and proportions of stone bridges, it must be granted that iron has many advantages compared with either stone or timber, as it is much lighter and more economical in the first outlay than the former, and more durable than the latter. It must not, however, be forgotten that, although iron construction may be considered the great invention and distinguishing peculiarity of modern times, there are also some very fine works in stone, brick, and timber. In the two former, however, no progress, worthy of peculiar notice, has been made, bridges of larger span having been executed by the Romans centuries ago. The largest span in stone, executed in England, is that over the Dee of 200 feet; but ancient examples are recorded to have been from 50 to 100 feet wider, which, with reference to the age when they were executed, must have called for a comparatively greater amount of skill. It is in iron therefore, with respect to the span, that the great merit of modern works consists; the changes in the different modes of applying this material have been gradual and progressive, and very similar to, though somewhat more rapid than, the changes in the different styles of architecture. The first iron bridge was erected about eighty years ago, and partook of the character of its predecessors in stone, being formed of cast-iron voussoirs or wedge-shaped blocks put together in ribs. From that time to the present there has not been much improvement in the construction of this class of iron bridges, and the span has only increased from 200 to 240 feet, which would appear to be the proper limit. Soon after the introduction of the cast voussoir principle, cast-iron beams were used for small spans of 50 feet, which eventually, by combination with wrought-iron trussing, reached as far as 100 feet. The greatest improvement was the formation of girders entirely of wrought-iron, which soon followed the production of rolled plates and bars of different forms and sections. This in a few years led to the execution of spans of 460 feet, the largest of rigid roadways with a level headway beneath, yet constructed. In suspension bridges, spans on this principle have been executed of upwards of 1000 feet. But as these, from their vibration, are quite unfit for the passage of heavy weights in rapid motion, they will not be treated on the present occasion.

Cast-iron bridges may be classed as follows:—The *arched rib*, the *trabeated*, and the *combination girder*. Wrought-iron bridges consist of the *tubular girder*, the *tubular bow girder*, the *large tube*, and *lattice girders*, with several varieties of combination.

The first iron bridge constructed in England is that over the river Severn near to *Colebrook Dale*. The design appears to have originated with Mr. Pritchard, architect, about the year 1773, and the works were completed in 1779. In this bridge five arched ribs of cast-iron support perpendicular spandril pieces, which carry the roadway. The ribs are nearly semicircular and have a span of 100 feet.

Sunderland Bridge, over the river Wear, the next cast-iron bridge erected, was designed by Mr. Rowland Burdon in 1792, to whom a patent was also granted, for "a certain mode or manner of making, uniting and applying cast-iron blocks to be substituted in lieu of key stones in the construction of arches." This bridge consists of six arched ribs of a segmental form 200 feet span and 30 feet rise. Each rib is 5 feet deep and consists of 105 separate blocks.

Buildwas Bridge over the river Severn, by Telford, is like the foregoing a single arch, 130 feet span with 27 feet rise. It consists of three arched ribs 3 ft. 10 in. deep.

Boston Bridge, by Rennie, is remarkable for the slightness of its rise, which is 4 feet with a span of 100 feet.

Southwark Bridge, also by Rennie, has the greatest span executed, that of the centre arch being 240 and of the sides 210 feet. The rise of the centre arch is 24 feet, that of the side arches proportionate. The arches consist each of eight ribs 8 feet deep at the springing and 6 feet at the crown. Each rib is cast in fifteen pieces of much larger masses than in previous works.

The *New Bridge, Westminster*, in course of construction, will also prove a valuable addition to this class of works.

Upon simple cast-iron beams it will not be necessary to say much. The first application of this material as a beam is due to Boulton and Watt, after whom it was extensively applied in construction by Sir.R. Smirke. Although useful in buildings, its fragile and treacherous character renders it hazardous for railway purposes. Capable of bearing a large amount of dead weight, it can be easily broken by a cross blow or the sudden shock of a passing train. Its span has reached 40 or 45 feet, and this only under very careful treatment.

With the view of remedying the defects of cast-iron girders, recourse was has to trussing them with malleable iron. Owing, however, to the unequal expansion and contraction of the two metals, and the fact that the two were seldom brought into action at the same time, the success of these beams has been very doubtful. They have been used in spans of 50 to 100 feet, but certain failures appear to have led to their disuse.

Lea Bridge was erected about ten years ago, the total length is 70 feet or 66 feet clear bearing. The girder is composed of two castings of an uniform depth of 3 feet, bolted together with wrought plates to the joints and trussing bars.

Dee Bridge, Chester, was the largest bridge of the kind; it crossed the river in three spans and had a double line of rails with a pair of girders to each. The total length of each girder was 109 feet or 98 feet clear bearing. It had an uniform depth of 3 ft. 9 in., and was formed of three separate castings. Cast-iron plates 13 feet long and 3 feet deep were bolted over the top of the joints, and a set of trussing bars was placed on each side of the girder. The thickness of the central part was 2⅛ inches, top flange 7 inches wide, the bottom 2 feet. The girders sustained the usual test, yet gave way under a much less load. The failure has been attributed to a variety of causes, but a not unfrequent one has been overlooked, viz., the manner in which the roadway was made to take its bearing on the girders. As a general rule, too much care cannot be taken to give the weight an uniform bearing in a vertical direction on either cast or wrought iron girders, more especially the former. Placing the planking or beams on the inside flange will, on the passage of every weight, cause a tilting vibratory motion; if the roadway cannot be placed altogether on the top of the girder, it should be carried underneath it and suspended with plates and bolts.

Tubular Girder Bridges owe their origin to the manufacture of wrought plate iron, which was first used in shipbuilding. Great improvements were soon made in the mode of joining and rivetting these plates, and the T, L, and double L iron manufactured by Mr. Fairbairn, led to the great works which were carried out after its application to railway purposes.

The *Liverpool Canal Bridge*, on the Blackburn and Bolton Railway, executed by Mr. Fairbairn, was the first application of these girders; the span is 60 feet. The *Liverpool Landing Stage Bridge*, erected by Mr. Fairbairn for Sir W. Cubitt, spans the space between the pier and the floating pontoon in deep water. Its total length is 152 feet, and 142 feet between bearings.

The *Gainsborough Bridge*, erected by Messrs. Fairbairn for Mr. Fowler, crosses the river Trent at the angle of 50°. It consists of two spans each of 154 feet. There are two girders to each span carrying a double line of rails; the girders are of an uniform depth of 12 feet; the top is strengthened by a double chamber 3 feet wide by 1 ft. 3 in. deep; the width of the girder below is 2 ft. 6 in. The sides of the girder are strengthened by an arched rib of a double L shape, 1 foot deep; the plates are 2 feet wide and ½-inch thick.

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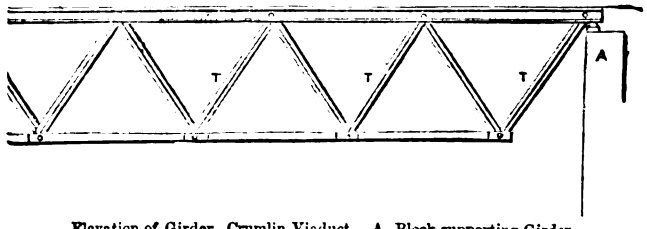
The *Britannia Bridge*, by Stephenson, has been fully described, and it is only necessary to give *chief* dimensions. It consists of four spans, the two main 460 feet, the two side 230 feet, and it is 90 feet clear of high-water mark. There is a tubular girder to each line of rails, the dimensions of which are 30 feet by 14 ft. 6 in. The form of this tube is square, and it is stiffened at the top and bottom by small cells, which answer to the top and bottom chords of the lattice girder.

The *High Level Bridge*, Newcastle, also by Stephenson, forms a junction betweeen several railways. It is remarkable for carrying a railway above and a roadway for street traffic below, and consists of six spans of 125 feet; the extreme height is 125 feet, and there is a clear opening of 80 feet above the water line. The weight is carried by arches on the level of the roadway, the bottom of which is suspended from it. The piers measure 50 by 16 feet, and are lightened by arches. The most striking and peculiar feature is seen from the roadway, which presents a series of dark arched ribs, with light bursting through the bars supporting the sides. The whole design is exceedingly good and the exterior handsome.

Before entering upon the subject of *lattice girder bridges*, it is necessary to glance at the timber viaducts, as it is from them that they derived their origin. The most remarkable of these structures are American. The greatest span is that over the *Portsmouth river*, 250 feet; the greatest height that over *Genesse river*, 230 feet. As English examples we may mention—*Dinting Vale* with a span 120 by 125 feet, *Landore* 109 by 90 feet. Amongst the earliest wooden bridges are those designed by Palladio, three of which have 100 feet span, two are framed on the ordinary principle of trussing, and the other on the arched rib or voussoir principle. The *Portsmouth River Bridge* is formed on the same principle as the last, with the addition of diagonal bracing to each voussoir. *Don Bridge*, near Aberdeen, is composed of a strong arched rib, in the spandrils between which and the level roadway above, is a filling in of framing distributing the pressure. *Schaffhausen Bridge* is similar in arrangement to the earliest American. The weight is carried by a series of raking struts, which radiate from one or more points on piers or abutments; they are bolted to the top and bottom chords of the girder, and transfer the weight of the roadway at regular intervals to the piers.

The *Portage Timber Viaduct*, the loftiest and most interesting piece of timber work of the kind, crosses the Genesse river at an altitude of 230 feet. This work, designed by Mr. Silas Seymour, was commenced on the 1st of July, 1851, and completed in a period of only thirteen months and a half. The whole length is 800 feet, the piers, 50 feet apart, are formed of wooden trestles standing on a base of stone 24 feet high. The trestles are formed of timbers 14 inches square at base and 1 foot at the top, the braces to the piers and girders are 6 inches by 12 inches, the number of vertical posts at the base are twenty-one, which diminish to fifteen at the top. Three rows of girders, 14 feet deep, formed of diagonal braces, support the roadway. The cost of the bridge was 35,000*l.*, the quantity of timber 135,500 feet. It was estimated that a stone bridge would have cost seven times the amount, and that the interest would renew the whole three times as often as would be required. This may apply in America, but the economy of using timber is very questionable in England.

My own professional engagements in the locality enable me to enter more at length into the description of the *Crumlin Viaduct* situated on the Newport, Abergavenny, and Hereford Railway Extension, which with the exception of the *Aqueduct of Spoleto* and the *Portage Timber Viaduct* in the United States, exceeds any other structure of the kind in height. It is a remarkable example of the modern application of iron to such purposes. The dimensions are as follow:—Total height from the bed of the river to the level of the rails, 200 feet; the piers from centre to centre, 150 feet: actual bearing of girder, 148 feet; the total length of viaduct, 600 yards. There are altogether ten spans or openings, but they are unequally divided by a tongue of land on which are placed masonry and earthwork, about 50 yards in length, making in reality, as far as ironwork is concerned, two separate viaducts. The larger viaduct has seven spans and six piers; the smaller one, three spans and two piers. Excepting the height of the piers from the level of the valley, the two are precisely similar, and it will be necessary only to allude to the larger one. The piers are formed of clusters of cast-iron columns, placed in stages. Each column is 17 feet long by 1 foot in diameter, cast hollow, the thickness of metal varying from 1 inch to $\frac{7}{8}$-inch, diminished within, the same external diameter and form of column being preserved throughout. The number of columns in each stage is fourteen, and they are arranged on plan, in the longer direction, in four rows of three each, with one standing singly at each end of the piers, which gives it a salient angular outline. The width between the columns at the base of the pier measures 13 ft. 6 in. in every direction, taken on the square, excepting between the two centre rows, where it measures 6 feet throughout the height. The pier gradually diminishes to the top of the columns below the girders, where the dimension 13 ft. 6 in. is reduced to 9 feet, and at the external angle columns to 2 feet. The dimensions of the piers at the base are between the centres of the columns 60 by 27 feet, and the upper dimensions 30 by 18 feet, giving a diminution of 30 feet in one direction and of 9 feet in the other. To effect this, nearly all the columns are more or less inclined, and the two centre are the only upright ones. The four columns at the corners, forming the square of the piers, lean diagonally 4 ft. 6 in. The six intermediate columns correspond, but lean each in one direction only. The two single outside columns are most inclined, being 11 ft. 6 in. out of the perpendicular, forming a raking brace. The top of each stage of columns is connected by horizontal cast girders 1 foot deep, with 5 inch flanges, bolted together. There are also horizontal and vertical wrought tie rods. The former are circular, and 2 inches diameter, and the latter flat bars, 4 by $\frac{3}{4}$ inch. They are tightened with wedges where necessary. The columns are fitted together with socket joints, a projection of $\frac{1}{2}$-inch being left on the top of the cap, which fits into the base of the column above. These are held together by four ears cast on the top and bottom, which are fixed with bolts and nuts. The joints of the columns are planed and fitted together with the greatest nicety to ensure a perfect bearing. The base plates upon which the columns stand vary from 3 feet to 5 feet in height, and have a plate 3 feet square resting on the masonry, into which they are joggled, plugged, bolted, and put together with sulphur joints. The number of stages of columns to centre piers, it will be perceived, are ten, without base plates. The upper stages of the columns are connected together at top by stronger horizontal girders than those below.



Elevation of Girder, Crumlin Viaduct.—A, Block supporting Girder. T, T, T, Principal Ties.

They are finished with A shaped or triangular trusses placed over each row of columns below, upon which the girders rest. It should be mentioned that the foundations for the piers are formed of solid, flat bedded and jointed masonry; they were generally carried down to the solid rock, and vary from 10 feet to 3 feet in depth. The largest blocks are placed immediately under the base of the columns, and so arranged as to distribute the weight below as much as possible. The girders are formed of wrought-iron after Warren's patent. This consists of a stout beam above, and a bottom tie below, with diagonal filling in, the whole being supported by the top beam on the principle of an inverted truss; the mode of execution, however, differs much. The girders at the Crumlin are 150 feet long and 14 ft. 6 in. deep, outside dimensions. The dimension of the top tubular beam is $14\frac{1}{2}$ inches by 9 inches; the average thickness of the plates being, the sides 1 inch, the top and bottom $\frac{1}{2}$-inch. The sides have flanges formed on the edges, which are rivetted to the top and bottom plate. Extra stiffening pieces are carried along the bottom, and likewise the joints and where the bolts cross. The ties at the bottom of the diagonals of the girder are formed of a series of four wrought bars, 6 inches by $\frac{3}{8}$-inch average, placed in pairs 3 inches apart in the centre to admit the diagonals and packing, and showing a 4 inch separation on face; the whole forming a square combination measuring 16 inches by 7 inches; these bars reach from diagonal to diagonal, where all four are joined with a plate 16 inches deep, and bolted with five $\frac{7}{8}$-inch rivets to each. There are eighteen diagonals to each girder, which act as struts and ties until they gradually approach the centre, where they act as both. The diagonals do not cross each

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other, as is the case in the lattice girder, but are both fixed to the top beam and bottom tie with large bolts 3½ inches diameter; and it is on the care and security with which these parts are connected that the chief strength of the girders depends. The diagonal ties and struts present a different section, the main strut being of a cross shape, measuring 10 inches to each extremity, cut out of ⅞-inch plates, with four 5 inch L angle pieces rivetted. The ties are formed of two flat iron bars 9 inches by ½-inch, which lap the struts, where they are rivetted top and bottom. The ties near the centre, extending two on each side, are strengthened by smaller pieces of T iron, to enable them to act in some measure in the double capacity of ties and struts. The part of the lower beam or ties between the four centre strains of diagonals is strengthened by an additional bar 4 inches wide, filling the space between the other bars, and rivetted like them to the junction plates. The whole girder is gradually strengthened by an additional thickness of plates towards the centre, given by a close calculation of the forces required to be resisted. The side plates of the girder and ties diminish from 1 inch in the centre to ⅜-inch at the ends. Each pair of girders is connected at each of the large bolts or pins with a 5-inch cast-iron hollow bar, with ½-inch thickness of metal. The bolts are passed through the ties, diagonals, and packing pieces, leaving the heads outside, the ends of the pin projecting about 1 inch; the end is then covered with a cast-iron cap, which is screwed or bolted with a 1½ inch screw into the centre of the pin, to prevent the same from drawing out. This affords a means of connection with the cast-iron bars by corresponding flanges, which are firmly bolted together. The bearing of the girder, by which the whole is sustained, is worthy of particular notice. It is held by the ends of the *upper beam only*, the lower one dropping in a state of suspension; the weight thus entirely rests on the last pin, which passes through the outside diagonal tie. The top of the angular termination of the piers is furnished with a casting 3 ft. 6 in. long and 5 inches wide, on the upper surface of which is a flat sinking ¾-inch deep. Under the ends of the upper beam are placed cast-iron blocks, hollowed out on the upper surface to receive half the diameter of the pin, and of sufficient depth to raise the bottom flanges of the beam clear of the sliding groove. This block has perfect freedom of play backwards and forwards to suit the expansion and contraction of the girders as affected by the temperature of the atmosphere or the superincumbent weight; for this purpose a space of 9 inches is likewise left clear between the ends of the beams. The ordinary expansion and contraction in summer, between midday and midnight does not exceed ¼-inch. The girders have been tested with a weight of 250 tons each, which produced a very slight deflection; and were the viaduct loaded with locomotives this would be seven or eight times as much as could be put upon them. The struts have also been tested with a crushing weight of 250 tons. The roadway is formed of 6-inch planking bolted to the beams, and it is intended that the rails should be laid on strong longitudinal framed sleepers. An ornamental cast-iron balustrade is fixed on each side of roadway. The whole viaduct is not straight on the plan, the approaches to the larger one being curved, to which the last spans of the viaduct accommodate themselves by a slight inclination southwards at the extremities. This viaduct has been described as one of the engineering wonders of the day, and it may be mentioned, that another projected by the same engineers, is of a much greater height. Messrs. Liddell and Gordon, were the engineers; Mr. M. W. Carr, the resident engineer; Messrs. Kennard, the contractors.

The *Sitter Viaduct*, on the St. Gall and Appenzel Railway, an account of the completion of which has just appeared, is one of similar construction except that the girders are lattice. It is close upon the same height and has four spans, the two centre being 138 feet, and the two side ones 130 feet, but on the whole is a work of less magnitude than the Crumlin.

Messrs. Kennard are now constructing some girders for bridges on an Indian railway, on the half lattice or Warren principle, with a reverse bearing to those of the Crumlin viaduct. The upper beam is cased, and the bottom tie is formed of bars much in the same way, but the support being altogether under the whole girder, the ties and struts are changed, and the last strut runs on to the bearing on the piers. The girders are 90 feet long and 7 feet deep, and are placed 14 feet apart. The roadway is sustained just above the bottom tie by suspending plates from the upper beam, which are also connected below and made to act as vertical ties to the whole. There are thirteen diagonals in each direction, and the pins connecting them differ in size according to the strain; the largest being connected with the bottom tie. They vary in diameter from 4 inches to 2½ inches from the ends towards the centre, and those to the upper beam from 3 inches to 2 inches in the same direction. The number of bars in the bottom tie increases from two to eight, which are very nearly of the same thickness.

The *Newark Dyke Bridge* crosses in one span a branch of the Trent at an angle so oblique as to render it necessary that the girder should be 240 ft. 6 in. long, whilst the width measured on the square between the abutments is only 97 ft. 6 in. This is also one of Warren's patent, but differs materially from the Crumlin, inasmuch as the top tube and the parts compressed are of cast-iron. Each line is carried by a pair of girders 13 feet apart, between which the trains run. The top tube or strut is composed of twenty-nine cast-iron pipes 13 inches diameter, the thickness of metal 1½ inch. The ends of these are turned and nicely fitted together and bolted; the cast-iron struts are of the form of a Maltese cross. Each girder weighs 122 tons 10 cwt., the whole bridge, including the platform, 589 tons. The deflection caused by two heavy goods engines travelling both fast and slow (60 tons weight) was 2½ inches. This bridge was erected before the Crumlin, and although the span is greater the preference must be given to the latter as being composed entirely of wrought-iron.

Chepstow Bridge, over the river Wye, by Mr. Brunel, is a remarkable example of the combination of the tube and girder, to which may be added a third principle, that of suspension. The whole length of the bridge is 623 feet, one half which is crossed by a viaduct girder of three spans, the remaining portion by a single span of 296 feet. The central pier is composed of six cast-iron cylinders 8 feet diameter below, placed in two rows of three each, the viaduct piers are in single rows of three in each. Two girders, of uniform depth throughout, carry each line of rails, those above the roadway are perfectly distinct and do not depend upon each other. Fifty feet above the large span a circular tube 9 feet diameter is placed, from which the roadway to each is suspended. This is done by two vertical frames of wrought-iron, dividing the girder into three spaces, the centre the widest, the spaces braced with cross chains in links similar to suspension bars. The main chains hang from the tube at the ends over the pier to the opposite corner at the level of the roadway, where they are joined across the centre on both sides of the girder, and the middle space is crossed by chains both ways, which give additional security to the centre of the girder. The tubes are carried at each end on seventeen rollers 5 inches diameter, which allow for expansion and contraction; the diameter of the pins which carry the leading chains is 7 inches. The girders are formed of single wrought plates, with top angular casing 3 feet wide, and a curved bottom flange. This girder is made strong enough for the 100 feet spans; and over the space three times that width, it will be perceived that it is supported in two intermediate parts, so that in reality the girder has very nearly the same bearing throughout. This is an extremely ingenious arrangement, the sectional quantity of material used with reference to the span being less than in any like structure. But it is to be regretted that from its want of symmetry and its lop-sided appearance, it is by no means an agreeable design. The *Great Saltash Bridge* is on the same principle, with four spans, the two principal not less than 445 feet.

The objection to combination girders does not apply to those made all of wrought-iron. In cast-iron the girder is broken by the first deflection, but no mischief is done to wrought before the trussing bars or suspension rods are called into action.

The *Boyne Bridge*, on the Dublin and Belfast Railway is one of the finest examples of the *lattice girder* which has hitherto been executed. The main span is 264 feet between the bearings, the two side spans 137 feet. At the end next the town of Drogheda are thirteen arches of masonry of semicircular form, 61 feet span; at the other end are three similar ones. These are built of finely wrought stone. The height of the bridge above water mark is 100 feet, allowing the passage of shipping without striking top gallant masts. The depth of the lattice girder is 22½ feet. It is formed of top and bottom wrought tubular chords, the area of the top chord where the greatest strength is required is 265 inches, where the least 137 inches; the lattices are placed on each side of the chord at an angle of 45°, 7 ft. 6 in. apart, forming double squares in height, the sizes vary from 10 inches by ⅜-inch to 4 inches by ⅜-inch according to the strains; they are closely

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bolted to cross braces at the intersections. There is a double line of railway, with the girders on the outside, measuring 24 ft. 6 in. in the clear; the roadway is supported on cross beams also on the lattice principle 7 ft. 6 in. apart, covered with 6 inch planking bolted down. The girders being joined over the piers form one length, and are fixed only on one pier, the other supports being the usual rollers working in grooves to admit of expansion. Sir J. M'Neill was chief engineer; Mr. Burdon and Mr. Barton were the resident engineers.

It will be perceived that the principle of the lattice girder does not materially differ from that of the large tube, the sides of the former being open with lattices where material is not so much required. With the same weight of metal the lattice girders will carry a greater load than tubes. The comparative duration has not yet been ascertained, but the lightness and elegance of appearance and several other considerations are greatly in favour of the lattice bridge. For further particulars useful reference may be made to notes of the comparative strength of the tube, Warren's and the lattice girder, by Mr. James Barton, C.E. Various opinions have also been given by eminent engineers which will be found in the Transactions of the Institution of Civil Engineers.

In forming a comparison of the materials to be used for any particular work, whether a bridge or a viaduct, many questions have to be taken into consideration, but none more important than that of economy. To arrive at that, the original outlay and the probable durability must be taken into consideration; and from what has hitherto taken place the conclusion arrived at appears to be in favour of wrought-iron; but it should also be noticed that metals can be destroyed by repeated vibrations, which have a tendency to separate the particles of which they are composed. As a sufficient excess of strength should be provided, this objection does not detract from the value of the material, while it demands additional skill and ingenuity on the part of the constructor.

Stone and Brick Viaducts.

	Height. feet.	Span. feet.	Length. yards.
Sunderland	130	160	200
Llangollen	145	90	550
Rhymney	140	40	400
Congleton	114	50	350
Ouse Valley	110	45	480
Folkestone	100	30	200
Stockport	100	60	600
Timber Viaducts.			
Dinting	120	125	200
Landore	109	90	600
Scotswood	—	60	350
American Timber Viaducts.			
Portsmouth River	—	250	—
Columbia	—	200	2200
Cumberland	—	175	1400
Portage	230	50	250
Iron Viaducts and Bridges.			
Crumlin	200	150	550
Sitter	200	137	200
Britannia	120	460	500
High Level	120	125	250
Chepstow	120	290	250
Boyne	120	260	350
Saltash	120	445	450

Stone and Brick Bridges.

	Span.	Rise.	Date.
Chester	200	42	1833
London	152	30	1831
Gloster	150	35	1827
Ponty Prydd	140	35	1755
Maidenhead	128	24	1835
Neuilly	127	35	1774
Waterloo	120	38	1816

Suspension Bridges.

	Span.
Niagara, Queenstown	1040
Wheeling	1010
Freyburg	820
Niagara, at the Falls	760
Pesth	678
Hungerford, London	676
Menai	580

THE RAILWAY BRIDGE ACROSS THE MISSISSIPPI.

THIS remarkable structure was opened for traffic on the 22nd April last, and was built for the Railroad Bridge Company, of which Mr. Henry Farnam is president and chief engineer. It connects the Chicago and Rock Island, and the Mississippi and Missouri Railroads, and was erected by Messrs. Stone and Boomer of Chicago, and Mr. Boyington, of the firm of Stone, Boomer, and Boyington, of Davenport, superintended the erection. The stone of which the piers and abutments were built was brought from Rock River, Le Claire, and Hampton. The timber comes partly from the Upper Mississippi and partly from Chicago and Buffalo, and the iron and castings from the works of Stone, Boomer and Bouton, of Chicago.

There are, however, two bridges—the "Slough Bridge," which crosses from Illinois to the island, over a channel which the Mississippi has made on the east side of the island, and the "Main Bridge," which extends from the island to the Iowa shore. The following is a description of

THE MAIN BRIDGE.—The main bridge extends from the island to the Iowa shore of the Mississippi, and consists of five spans besides the draw. Three of these spans are on the west side of the draw, and two on the east side. The entire length of the bridge from the island to the Iowa shore, is 1581 feet. Each span is 250 feet in the clear, and the draw is 286 feet.

The Piers.—The piers of the main bridge are 7 feet wide at the top by 35 feet long. They are 38 feet high from the bed of the river, and rest on the solid rock. They have a batter of three-fourths of an inch per foot. The north ends of these piers have a cut-water, so shaped and made that it cuts the ice at once as it floats down the river, thus guarding the piers against the force of the ice-cakes which rush down the rapids at the breaking up of the river every spring.

The abutment on the east side is 35 feet high with a batter same as piers. The abutment on the west side is 30 feet high, with a batter equal to the other. They are T abutments.

The Chords.—The bottom chords are 15 inches deep by 34 inches wide, and consist each of four pieces of timber. The top chords are each 12 inches deep by 34 inches wide, and consist also of four pieces of timber each.

Arch Beams.—There are four arch beams to each span of this bridge, each of which is 32 inches deep and 10 inches thick, and are composed each of five pieces of timber, 6 inches by 10 inches. These pieces are set apart one-quarter of an inch from each other, and fastened together with iron plates and bolts, at intervals along the arch. The ends of the arches rest on the piers 13 feet below the lower side of the bottom chords, and rise at the centre up to the lower side of the top chords.

The Braces.—The main braces in each span number one hundred on each side of the bridge, two running abreast, and gradually vary in dimensions from 12 inches by 12 inches at the extremities, to 9 inches by 12 inches at the centre. There are fifty counter braces running singly in an opposite direction to and between the main braces, the whole three braces being held together where they connect by iron shoes and bolts. The centre braces are 9 inches by 10 inches.

Truss Rods.—The truss rods gradually vary in size from 2¼ inches diameter at the extremities to 2½ inches at the centre of each span. There are five rods abreast in this bridge, three of which belong to the truss, and two suspending the truss to the arch—one rod on each side of the truss.

Bearing Blocks.—There are one hundred cast-iron blocks to each span, fifty at the top and fifty at the bottom chords. These blocks are in the shape of an Λ slightly depressed, so that each brace and counter brace, which are always cut square at the ends will rest fairly against it. Each one of these blocks weighs 400 lb., and in order to raise these monstrous blocks to their position on the top chords, a new machine had to be specially erected.

The Draw.—The length of the draw is 286 feet—the largest in the United States. The openings are each 120 feet in the clear. It is built like an arch top chord.

Centre Pier.—The centre pier for the draw is 32 feet in diameter at the top, with a batter three-quarters of an inch per foot. It is protected by a crib running up and down the river, of 350 feet long by 40 feet wide. The northern end of this crib is faced with boiler iron, so as to cut the ice.

The Chords.—The bottom chords are 13 inches deep by 26 inches wide. The top and arch chords at the centre are 36 inches deep, and 26 inches wide, gradually lessening to 12 inches deep by 26 inches wide at the ends. The centre of the arch chords contains twelve pieces of timber, which decrease to four pieces at the extremities.

The Braces.—The dimensions of the main braces are 9 inches by 10 inches, gradually lessening to 7 inches by 10 inches. The counter braces are 7 inches by 9 inches.

Truss Rods.—The truss rods in the draw run three abreast. They vary from 2 inches to 1½ inch in diameter.

Bearing Blocks.—The cast-iron bearing blocks are similar in construction to those on the bridge, and weigh 130 lb. each.

Turntable.—The turntable track is 28 feet in diameter, and there are 20 wheels under the draw.

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THE SLOUGH BRIDGE.—The Slough Bridge as it is called—*i. e.*, the bridge from Illinois across the channel of the Mississippi that runs between the island and the main land—consists of three spans of 150 feet each in the clear.

The Piers.—There are two solid stone piers each 25 feet high, from the bed of the river, resting on solid rock. They are 5 feet wide at the top, and 35 feet long, with a batter of three-fourths of an inch per foot. This bridge has T abutments, 5 feet wide by 25 feet long, the same height as the piers.

The Chords.—The bottom chords of this bridge are 13 inches deep, and 29 inches wide. The top chords 10 inches deep, and 20 inches wide. The bottom braces are composed each of four pieces of timber, and the top chords of four pieces.

The Braces.—The main braces in each span gradually vary in dimensions from 9 inches by 10 inches at the extremities, to 7 inches by 10 inches at the centre. The counter braces in each span are 8 inches by 9 inches.

Truss Rods.—The truss rods in this bridge are set three abreast in each truss, and range from 2 inches in diameter at the extremities, gradually decreasing to 1¼ inch at the centre of each span. They are held at the ends by a heavy nut and screw, which, as they are tightened draw together the top and bottom chords of the bridge.

Bearing Blocks.—There are cast-iron bearing blocks in each span, at the top and at the bottom chords.

The blocks are the shape of an A slightly depressed, and are cast so that each brace, which is cut square at the ends, will rest fairly against it. In each of these blocks are three sockets, through which the three truss rods pass abreast. Each of these blocks weighs 185 lb.

Lateral Bracing.—The lateral bracing is in accordance with and corresponds with the trusses on each of these bridges.

THE ORDNANCE SURVEY OF SCOTLAND.

THE Select Committee appointed by the House of Commons to consider the Ordnance Survey of Scotland, have made their Report. It appears that when the Ordnance Survey was first undertaken in 1784, it was merely intended to produce a military map of the southern counties of the kingdom, but that as the work advanced it came into general favour as a road map, a travelling map, a county map, and general geographical map; that so it continued till 1824, when Lord Monteagle and the Irish members of Parliament came to the conclusion that it would be advisable, in the adaptation of the national survey to Ireland, to secure some further social advantages, and especially to make it subservient to the proper assessement and collection of the grand jury cess and other local taxes in that part of the kingdom; that a committee of the House of Commons sat in 1824, which recommended a townland survey of Ireland, on a scale of 6 inches to a mile; that a 6-inch scale was accordingly adopted; and that when a portion of Ireland had been completed, the government was further induced to extend the details of the survey from the boundaries of townlands to the subdivisions of fields.

In 1840, all England, with the exception of the six northern counties, had been surveyed on the scale of 2 inches, and published and engraved on the scale of 1 inch to a mile; and a small portion of Scotland had been previously surveyed on a similar scale.

The survey of Scotland was suspended in 1828, in order that the survey of Ireland might be proceeded with; that previously to that suspension, the county of Wigton, and one-half of the counties of Ayrshire and Kirkcudbright had been surveyed and drawn for the 1-inch scale; and that on the completion of the survey of Ireland in 1840, the survey of Scotland was resumed on the 6-inch scale, which had been found of such great value in the survey of Ireland. Thus the work which had been previously done on the 1-inch scale was thrown away; and the distinction between the peculiar advantages of a 6-inch survey, as applicable to the townlands of Ireland in comparison with the larger territorial divisions of Great Britain, was not at that time sufficiently taken into consideration. The survey was proceeded with in the three counties of Wigton, Kirkcudbright, and Edinburgh, which were accordingly mapped and engraved by the Ordnance on the 6-inch scale.

The next step of importance was Lord Elcho's Committee on the Scotch survey, which sat in 1851. The state of the case as regards Scotland then was, that a 6-inch map had been resolved upon, but no 1-inch map. The question before the Committee was simply whether they would have a 6-inch map or a 1-inch map. An alternative between those two maps was the only question proposed to them, and they pronounced in favour of the 1-inch map, on the ground that it was better adapted to geographical purposes, and that the 6-inch map alone was not of sufficient public utility to justify the large expenditure of public money that was required. The Committee also appears to have acted under a general impression, that by dispensing with the 6-inch scale, the 1-inch scale would be more speedily proceeded with.

Orders were given by the Treasury and Ordnance in conformity with the report of that committee. Lancashire, Yorkshire, Kirkcudbrightshire, and Edinburghshire being nearly finished, were ordered to be completed on the 6-inch scale; and the remaining four counties of England and the rest of Scotland were to be done on the 1-inch scale.

These instructions produced the greatest dissatisfaction in Scotland and in the unsurveyed portion of England.

Consequently, in 1852 and 1853, numerous representations were received from Commissioners of Supply, Royal Burghs, and various bodies in Scotland, and from the magistrates and others connected with the colliery and mining interests in the north of England, the object of which was to induce the Treasury to rescind the orders which had been given in accordance with the recommendation of the Committee of 1851 in favour of the 6-inch scale. Some of these memorials were referred to the Board of Ordnance by the Treasury in June, 1852; and a determination was come to by those departments that the survey of Fife, which was at that time going on, should be conducted on the 6-inch scale, and that the question of the scale as to the rest of the country should be reserved for future consideration. Meanwhile the desirableness of an increased scale was much discussed by professional persons, and a more mature knowledge of the subject was arrived at.

In February 1853, Lord Elcho drew up a very able memorandum on the survey, which, with numerous letters on the subject, was transmitted, with the Treasury circular letter of the 16th April, 1853, to a large number of the most experienced and scientific societies and persons in the kingdom, requesting them to state their opinion on the comparative merits of a 6-inch as contrasted against any larger scale, for the purposes of a national survey; it being understood that the inch scale would under any circumstances be proceeded with. The replies were as follow:—In favour of the scale of six inches, 32; in favour of a larger scale, 120. The weight of authority being in favour of a larger scale, a second circular was addressed to the same parties, requesting them to state what scale they would recommend.

These replies were, by a Treasury Minute, dated June 13th, 1854, submitted to Sir John Burgoyne, Mr. Blamire, and Mr. Rendel, with instructions to report the result of the answers to the Treasury Circular of 1853. They unanimously reported that the weight of the evidence in the printed correspondence before them was decidedly in favour of the scale of one two-thousand-five-hundredth part of the linear measure of the ground to be mapped (popularly termed the 25-inch or one square inch to one acre scale).

Under these circumstances, the Treasury determined, by a minute, dated July 15th, 1854, "That the surveys of Ayrshire and Dumfriesshire should be laid down and drawn on paper on the scale recommended by the Committee, *i.e.* of one two-thousand-five-hundredths of the linear measurement of the ground; also, that until a final determination should be arrived at as to the scale upon which the Ordnance Survey should be conducted and engraved, the course which has been authorised in reference to Ayrshire and Dumfries-shire should be applied to other districts."

Colonel James, the present superintendent of the survey, was first employed as a director of the Ordnance Survey in 1854. On the 18th of May, 1855, the Treasury recorded a minute, founded on a report and memorandum submitted to them by Colonel James, in relation to the engraving of the Ordnance Survey of Scotland, which required immediate steps to be taken, in which their lordships stated that they have arrived at the following conclusions:—

1. That it is unnecessary to have plans of the Highlands and uncultivated districts on the scale of one two-thousand five-hundredths, and that the superintendent of the survey should exercise his discretion as to the districts, the plans of which are to be made on that scale.
2. That plans on the one two-thousand-five-hundredths scale should not be engraved, but that copies, when wanted, should be made by the anastatic process.
3. That the Highland and other partially cultivated and thinly peopled districts should be drawn on the scale of six inches to a mile, and copies, when wanted, should be furnished by the anastatic process.
4. That the general map of Scotland on the scale of one inch to a mile should be proceeded with as rapidly as possible.
5. That the plans of towns containing more than 4000 inhabitants should be drawn on the scale of one five-hundreths linear measurement.

The Committee find that since the Ordnance Survey has been undertaken, and general attention has been more immediately directed to its object, there has been a gradual progress of public opinion in favour of conducting it on the larger scale of 25 inches to a mile, equal to one inch to an acre. This has been most ably explained by Sir Roderick Murchison, Sir John Burgoyne, and Sir C. Trevelyan, who all concur in stating that the further the larger survey has proceeded the more they have become prepossessed in its favour. It is likewise worthy of observation that at Aldershot, Portsmouth, and in several places in the south of England previously surveyed on the one-inch scale, a re-survey on a scale of 25 inches to the mile has been found essential for military purposes.

The idea of a cadastral survey of 25-inches originated with Delambre and Laplace in 1793. A commission, of which they were members,

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recommended it to Napoleon in 1807, who adopted it, and carried out the survey of France upon that scale with signal success. It appears, from a paper laid before the Committee, that the proposal to adopt the 25-inch scale in Great Britain originated with Colonel Dawson, attached to the Tithe and Inclosure Commission, who stated, that had his suggestions been adopted in 1837, when the 1-inch Ordnance maps were found utterly inapplicable to and useless for the purposes of the Tithe Commission, an expense of 3,529,830*l.* might have been saved to the country, besides a further considerable outlay in respect of surveys for roads, canals, water supply, and the sale and transfer of property, which he has no means of estimating.

Very valuable evidence has been given by the Lord Advocate of Scotland as to the effect of the adoption of a survey on the 25-inch scale, on mortgages and transfers of landed property. Mr. Vignolles stated that in Bavaria, where he has been extensively employed in surveying, all transfers of land are made by cadastral maps, on a 25-inch scale; that no practical difficulties occur in the use of these maps, and that he does not believe that there would be any difficulty in applying a similar system to Great Britain; that it would be necessary to re-register property transferred in this manner, when it was subdivided and sold in separate lots, but that in Scotland, where every conveyance and transfer of property is registered, every difficulty would be obviated by employing the same officers who are employed in registering deeds, to register the plans also; that the greatest advantages have been practically derived by him as a civil engineer, from maps similar to those proposed to be made from the Ordnance Survey of Scotland, specimens of which were hung up in the committee-room, and which are similar to those in general use in Bavaria, Baden Baden, and Switzerland.

The Committee have examined into the estimates and probable cost of the survey, as proposed by Colonel James; and find that, after a year and a half's experience, his original estimates are fully borne out and confirmed in practice, and that a sum of 917,000*l.*, of which 284,000*l.* has been already expended, will cover every expense attendant on the 25-inch cadastral survey of Scotland, including the publication of maps on the reduced 6-inch and 1-inch scales, and the maps of the towns on 10 feet to the inch scale.

That for the 6-inch survey alone 817,000*l.* would be required, including the publication of the maps, and for the 1-inch survey alone 250,000*l.*, including the publication of the maps. That the difference of the cost of surveying between the 25-inch and 6-inch surveys would be comparatively immaterial, and that the recent introduction of the anastatic and photographic processes, the substitution of piece-work for day-labour, and many other improvements detailed in the evidence, will lead to increased economy in producing reduced maps from an enlarged survey.

It also appears that 76,000*l.* has already been paid back into the Treasury for maps sold, and that the Treasury are now realising 4000*l.* annually from the sale of Ordnance maps; that a year more will pay off the cost of engraving Ireland, and that a few years more will repay the cost of engraving Scotland; and that the superintendent of the survey finds, from experience, that as regards the 25-inch maps, thirty-three copies taken by the anastatic or zincographic process will repay the entire cost of production, and that he feels quite confident that if his suggestions with regard to the publication of the 25-inch scale map are followed, the entire cost of the publication will be eventually repaid at no distant period.

Of the 917,000*l.*, deducting 284,000*l.* already expended, there remains a sum of about 633,000*l.* required to complete the survey of Scotland in the manner proposed. That sum of 633,000*l.* would be spread over ten years, thus making an annual vote required to complete the survey of Scotland, on the most approved principles, of 63,000*l.* a year.

In Ireland a 6-inch map and a 1-inch map will have been obtained at an expense of 1,293,014*l.*

In England and Wales a 1-inch map has been obtained, exclusive of the six northern counties, at an expense of 989,219*l.*

England and Wales together are estimated to contain about 60,000 square miles, Scotland about 30,000 square miles, and Ireland about 30,000 square miles.

The survey of Scotland, conducted and completed in the manner recommended by Colonel James, can therefore be produced for about 360,000*l.* less than the survey of Ireland has cost.

The Committee consider that the question is not one which is to be considered solely on a financial basis. Whatever the first outlay may be, it may hereafter be found, as has proved to be the case in France, that it is more economical, in the first place, to produce a large cadastral map, from which other maps on smaller scales can be reduced at a trifling expense, than to re-survey the ground, as has been the case both in England and Scotland, owing to the insufficiency of the parent survey.

The Committee advert to the delay in executing the Ordnance Survey, which has been justly complained of by many of the witnesses examined. It appears that this delay, which extended to about twenty years, has been partly caused by the transfer of the whole of the Ordnance surveying staff to Ireland in 1827.

The time has now arrived when it is absolutely necessary for Parliament to consider, and finally determine, the comprehensive question, What is the nature of the survey which they are prepared to sanction as the one which will most conduce to the general interest of the nation at large.

The Committee have decided in favour of the one two-thousand-five-hundredth scale for a cadastral survey of the country. In doing so, they are influenced by the great advantages which may be anticipated from the prosecution and completion of such a national work on principles which have been already successfully acted upon in the surveys of France, Bavaria, Switzerland, and other countries in Europe.

Of the purposes which a national survey ought to subserve, some of the principal appear to be—

1. The registration of titles.
2. The simplifying and cheapening conveyances of land, deeds of sale, leases, and all transfers of landed property.
3. Local valuation and assessments.
4. Adjustment of civil and ecclesiastical divisions.
5. Inclosure of waste lands.
6. Sanitary purposes.
7. Statistics.
8. Parliamentary purposes, in reference to standing orders.
9. Geological and mineral surveys.
10. General drainage, water supply, and engineering purposes.
11. Military and purely scientific purposes.

To secure such advantages as these, it is essential that a national survey should be conducted on a scale which, at the same time that it is susceptible of reduction for geographical uses, is also large enough to be available for general purposes of utility to all classes of the nation.

It has been proved that, unless the survey be conducted on a scale large enough to admit readily of the insertion of all the names and places in the populous mining and manufacturing districts, the attainment even of a correct geographical map is always difficult, and in many cases entirely impracticable. It has also been established that areas cannot be accurately measured from the paper (which is the real test of the practical usefulness of a cadastral survey) on a scale of less than 24 inches.

The Committee advert to the fact that, while it is possible to reduce, it is impossible to enlarge a parent map. A survey conducted on a small scale is liable to error; and the error, however small, if magnified even by the stretching of paper or other accidental causes, may be and has been productive of serious consequences; they therefore recommend the completion of the Ordnance Survey of Scotland on such a scale and in such a manner as will secure the greatest accuracy and uniformity on the one hand, and make the most of the work that has been already done and engraved on the other.

Thirteen counties in Scotland have been already surveyed. Those comprehend, with the exception of Lanarkshire, Perthshire, Aberdeenshire, Forfarshire, and a few of the north-eastern counties, by far the most important of the populous and cultivated districts, to which alone the survey on the 25-inch scale is to be limited. It is admitted that, under any circumstances, a map of the Highlands, published on a 1-inch scale, must be produced.

The plan recommended by the Committee, which will be completed for 633,000*l.*, includes an estimate for a publication of the Ordnance Survey on both the 6-inch and 1-inch reduced from the 25-inch scale. The production of a 1-inch Ordnance map of the whole country as speedily as possible is an essential part of the plan. It is admitted, that for the sake of accuracy, the survey for a map on a 1-inch scale must be conducted on a larger than a 1-inch scale; and as no unnecessary delay can occur by adopting the 6-inch as the intermediate scale for the production of the 1-inch map, the Committee recommend that it should be proceeded with. The plans on the 25-inch scale, though admirably adapted for the purposes above-mentioned, are too large for use out of doors. Contoured maps for engineering, geological, and several other purposes, on a uniform and intermediate scale between the 25-inch and the 1-inch are required. Such maps can be sold at a price which will cover the entire cost of making them, and they will be found of great value as maps of reference for many public as well as local and private purposes. The Committee think that it would not be real economy to incur the expense of a national survey, without, by the publication of such maps, deriving the utmost advantage from it. The completion of the publication of the 6-inch maps is necessary to render the survey uniform in both the Highland and Lowland districts.

Even for those who may doubt whether, in the first instance, a survey founded on the cadastral 25-inch and intermediate 6-inch scale is the very best that could have been adopted for Scotland, yet, adverting to the fact that five counties have been already surveyed on the 25-inch scale, that eight counties are actually engraved on the 6-inch scale, and that more are in progress, it is a matter for consideration whether, under these circumstances, it may not be wise to execute at the further outlay of 633,000*l.* in ten years, a survey of Scotland on principles on which similar national works have been performed with success in other countries in Europe, and which will be available for the general purposes above enumerated.

The Committee have had under their consideration the several methods which have been recommended or adopted for ascertaining and recording levels, viz., by levelling the sides of each triangle, as was first done in Ireland, by which method the heights of definite points on the summits

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of the hills, and the height at which every line crosses the roads or streams is given, or by means of contours at given altitudes, following all the sinuosities of the ground, and "bench marks" on fixed objects on the main roads, and other permanent surfaces.

This subject has been under the consideration of other Committees of the House of Commons, and of a Special Commission composed of distinguished scientific gentlemen.

The Committee are of opinion that the weight of evidence greatly preponderates in favour of the system of contouring now in operation, and which is working satisfactorily.

The Committee think that in such an important matter, purely financial considerations ought not alone to prevail; but having satisfied themselves that a national survey, if conducted on proper principles, will go far to reduce, if it will not wholly repay, the original cost of publication, they have come to the conclusion that the expense incurred would prove a beneficial application of public money.

ROYAL INSTITUTE OF BRITISH ARCHITECTS.

Abstract of the Report of Council to the Annual Meeting, May 5th.

THOUGH causes, happily now removed, have existed during the last two years to direct public attention and expenditure to other objects than the pursuits of peace to which this Institute is devoted, the council have the gratification of stating that the list of members has fully maintained its average increase, and that the balance sheet consequently exhibits a satisfactory financial result.

The Institute has to regret the decease of Messrs. G. T. Andrews, A. J. Green, J. E. Gregan, Fellows; of J. Neeld, and W. M. Nurse, Honorary Fellows; of Cavaliere Pietro Nobile, Herr Sprenger, and Mynheer Weenink, Honorary and Corresponding Members. The institute now consists of 136 Fellows, 127 Associates, 15 Honorary Fellows, 18 Honorary Members, 81 Honorary and Corresponding Members, and 7 Contributing Visitors.

Though not members of the society, it may here be permitted to allude, with feelings of respect and regret, to the decease of another Parisian Architect, M. Letarouilly, who has not survived to witness the completion of his valuable work on the Edifices of Modern Rome; and of Mr. Thomas Cubitt, one whose name may pass as a synonym for the boldness and magnitude of the building undertakings of the present day, in this our modern Babylon.

Under the highest sanction, the Royal Medal was this year awarded to an English Architect—Mr. Tite, M.P., Fellow, on whom our noble President passed a very high eulogium when presenting it, at a very numerous meeting of the members and visitors of the Institute.

The competition for the medals having been much more satisfactory than on many previous occasions, the Soane Medallion was awarded for the first time since the year 1848, and Medals of Merit were given to two other competitors. The numerous applications for the printed conditions of the competition of the present year induce the hope that the drawings to be expected will equal those which have just been rewarded. The new class of subjects offered for the Institute Medals will, it is trusted, meet with due attention from natives of Ireland and Scotland, anxious to bring to light the remains of interesting buildings in those countries which have been hitherto neglected, or known only to a few.

It would be satisfactory to be enabled to state that the prize offered to the students class had excited the same spirit of emulation.

The new Metropolitan Building Bill, introduced during the last session of Parliament by the late Sir W. Molesworth, then first Commissioner of Works and Public Buildings, received due attention from the committee entrusted by the institute with the charge of watching its progress, under the able chairmanship of Mr. Tite. Modifications were introduced in certain portions to which objections had been raised, and the council feel it due to Mr. Tite to record the special attention which he gave to supporting the interests of the profession both before the Special Committee of the house and in his place in the house itself; and particularly to state, that through his instrumentality the clause empowering the institute to examine applicants and grant certificates of competency to discharge the duties of district surveyor was introduced into the Act; a clause, it should be borne in mind, which recognises this institute as a body essentially conducive to the general welfare of the community.

The examiners appointed under this Act, viz., the Vice-Presidents and Honorary Secretaries for the time being, with certain other Fellows to be chosen annually by the institute, have already held two quarterly meetings. Applicants, on passing their examination, receive a certificate of competency under the Corporate Seal of the institute, which renders them eligible for election to the office of district surveyor by the Metropolitan Board of Works, to which the charge of selection is now intrusted. In examining applicants and granting certificates, the institute proceeds on the definite understanding that the Corporate Seal is affixed to the document solely to enable the parties to seek admission as district surveyors under the Metropolitan Buildings Act, and not for the purpose of canvassing for any other office whatever.

As soon as the Metropolitan Board of Works was constituted, the council of this institute represented to the chairman the necessity for passing certain regulations respecting the width of streets, which had been omitted in the Building Act, and they have the satisfaction to state that prompt and satisfactory attention was given to their representation.

The council feel that it is as yet premature to pronounce an opinion upon a subject of so great importance as the establishment of an examination with reference to granting a diploma in architecture. That before they could recommend the institute to undertake such a charge, it would be necessary carefully to ascertain the opinions of members of the profession generally.

They moreover feel that the duty which has been recently intrusted to the institute by the legislature, namely, the examination of the candidates for the office of district surveyor, will enable them, after a sufficient experience of such examinations, to come to a sounder judgment than they can at present on the subject of the diploma.

At the request of the committee, the council examined and drew up some brief observations on the objects connected with building in the Architectural Exhibition, 1855-56, which were afterwards laid before a meeting of the exhibitors. The council would here repeat their conviction, then stated, that the periodical collection of such objects in an exhibition devoted entirely to architectural purposes, must be highly advantageous to the public as well as to architects and the exhibitors.

The members will have learnt from the letter forwarded to them by Mr. Scoles, Honorary Secretary, that he declines being again put in nomination for that office. The council feel that the institute must sincerely regret the loss of the valuable services rendered for the last ten years with so much urbanity and skill by Mr. Scoles, in addition to the assistance which he has afforded during more than twenty years as a member, who joined the institute very soon after its establishment.

The council have much satisfaction in recommending that the honorary office thus vacant should be confided to Mr. Digby Wyatt, whose name is well known in connection with the Fine Arts, both at home and abroad, and who has consented to be put in nomination at the request of many influential members of the institute.

The council having ventured to suggest to the directors of the East India Company the advantage of allowing the interesting set of drawings, exhibited last session, of buildings at Beejapoore, to be copied for distribution, have much pleasure in learning from Mr. Fergusson, Associate, through whose intervention the drawings were made, that photograph copies are now being made under his direction—an instance of attention to the interests of art on the part of the Honourable Company well worthy of imitation by other public bodies.

Application has been forwarded by the council to the French minister of State, requesting that this society may be placed on the list of scientific bodies to which copies of the work on the mediæval buildings in France, published by the government, are presented. Some interesting medals, having on the reverse representations of important edifices, and sundry prints, illustrative of French palaces, from the collection at the Louvre, have been purchased.

The addition of 200*l.* stock to the funded property, and the balance now in hand, display a satisfactory state of affairs, to the maintenance of which each member is invited, by individual and conjoint operation, still further to contribute.

ACOUSTICS.

(Concluded from page 220.)

It will be, of course, observed that we do not want echoes in our buildings to enable us to hear; but they *are* and will be there, and my pleading is, that we should make them friends by alliance, and not leave them enemies by neglect. Thus, if the antagonist, or echoing wall or ceiling, be deprived by *interception* of most of the supply of the waves of sound that otherwise would have reached it, and should those that do reach be divided or broken by a cellular formation, or not allowed to "*run*," as it is called,—the cellular formations and those interceptions will form minor echoes, and thus be serviceable rather than injurious reflections (if I may use the word) of the voice or music, because they will return, through the short distances they shall have been reduced to, *in time*, to combine with, to elongate, and to aid the note or voice they otherwise would, like a tardy accompaniment, have clashed with or *interrupted*.

A very remarkable instance of the evil of neglect in such a case was afforded some years since in the capital of Ireland. A very large dinner-room was wanted for a peculiar emergency, and in *twenty-one days* a room not less than 90 feet in diameter, of brickwork, sprung up to its proportioned height, and was roofed in. It may well be believed that architectural detail was not attended to; consequently, though with the example in the same city of another circular room of 84 feet in diameter,—one of the best hearing rooms in Great Britain,—the new room was, for hearing,

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an entire failure. It is true there were neither breaks, pillars, or pilasters, niches, recesses, or panels, on either ceiling or walls, while the 84-feet room, or Rotunda, the beautiful and successful design of Gandon, has a fortunate profusion of them.

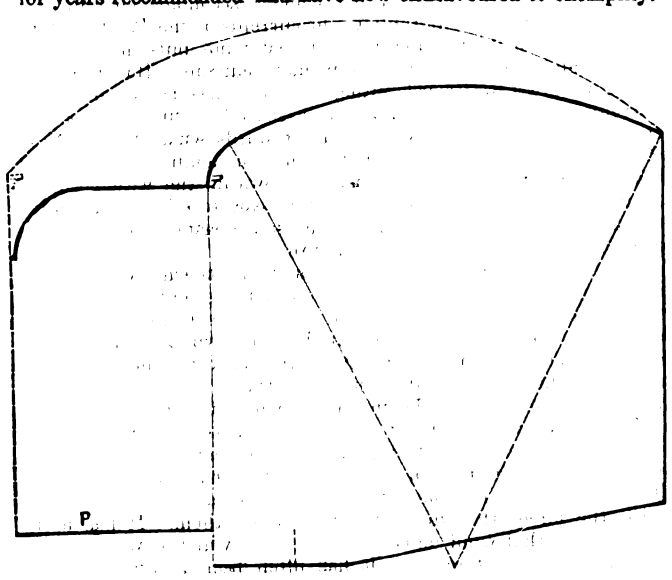
The law courts in St. George's Hall, Liverpool, as to hearing, have been pronounced failures; it is even asserted that the juries have been brought upon the *table* that they might be able conscientiously to discharge their duty, by hearing what they were assembled to adjudicate upon. This is bad, but it is little more than an oversight; the courts are too lofty, and, it may be said, there is no aid whatever to the human voice, although the appearance and the architectural proportions are both very elegant.

In a recent sketch of the life of the veteran Braham, it was stated that the St. James's Theatre, though built by him for an opera house, "never satisfactorily answered the purposes for which it was erected." Then, there are many old-fashioned but most comfortable-hearing theatres, even with great stage capacity, like the Princess's Theatre, Oxford-street, where the advantageous position available to the performer, and the number and boldness of the breaks or interceptions above and around him, make up for acoustic deficiencies of formation which are, in some degree, inseparable from the requirements of theatrical structure.

How many places are there in this great city, where the attraction, indeed the great use, depends on hearing satisfactorily, yet where the provision for that hearing is lamentably overlooked? How many theatres, too, for the sake of a light and architectural appearance, are built on the *reception-of-sound* plan, the thoro'-dome principle (as if mankind were giants),—the proscenium being included in and forming a portion of the audience-part of the theatre; the curve of that dome itself being questionable, and the height an objectionable necessity!

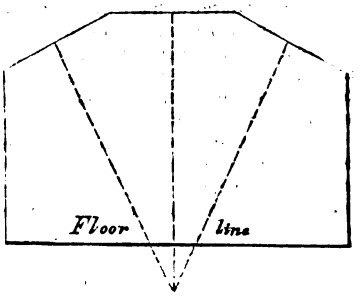
The Lyceum, formerly a bad-hearing theatre, has been greatly improved by its alteration from the thoro'-dome principle by the advancing of orchestra and audience part into the stage, giving an opportunity, as it were, of forming a new proscenium which has at least got a portion of independent ceiling or sound-interceptor to itself. The completion of the proscenium would render this beautiful theatre most excellent for hearing, for the interceptions are so complete beyond the wings, that strains sung behind the scenes have been heard even more satisfactorily than those sung at the foot-lights.

I annex a diagram or section of a theatre of the largest class, for the purpose of contrasting the thoro'-dome principle with that recommended as affording the greatest assistance to the performer, and the greatest advantage to the audience. Since first writing this paper, I have had an opportunity of minutely inspecting the ceiling and other arrangements of Her Majesty's Theatre, and was gratified to find that the lines adopted in this magnificent and perfect-hearing structure are those which I have for years recommended and have now endeavoured to exemplify.

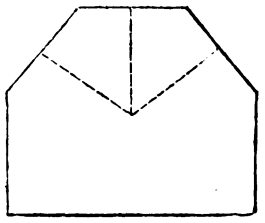


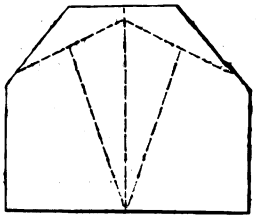
The performer, standing in a perfectly *ceiled* and *sided* space of at least 20 feet in depth, has that ceiling, of the best form that could be adopted, 17 feet nearer to him than the thoro'-dome principle would admit of.

Successes, whether accidental or intentional also afford instruction.—Exeter Hall, though without galleries, and accommodating so large a number of persons, undeniably possesses great power of distributing sound. The speaker, or singer, is well raised, and advanced into the area; the straight line of the wall is well broken, and the planes of the ceiling surfaces are really the tangent lines to about the best curve that could have been chosen, as its radii would at least reach the auditory, if not extend through or below the floor on which they are placed.



Not so the House of Commons. The circle to which the planes of the ceiling may be considered tangents, would be of so small a diameter that the radii, instead of passing through, would never reach any portion of the assembled auditory, or even of the members themselves; the effect being, that positions may fall to the lot of honourable members where, when speaking, they are said to be "inaudible"—no doubt, from what is called "the noise and confusion in the house," but which really proceeds from or is increased by conflicting, antagonistic, and ungoverned echoes. In defence of, or to account for this, much may be said of the classic severity of the very beautiful style of architecture which has been so variously and wondrously carried out in this greatest of modern structures; but architecture is made for man, not man for architecture; and an art loses its value if its limits compel us to construct what we do not want, or that which may not suit us. Possibly, without a very great innovation, a ceiling could have been adopted, or at any time supplied, at a comparatively trivial expense; the section to resemble, say, a Henry VII. arch. The radii of the larger portion could easily be made to reach quite to the floor of the house, while the quick-springing curves at the sides would form the best "interceptors," and be invaluable as aids to the reporters and others in the galleries.





The Foundling Hospital Church, accommodating a very large number of persons, is a happy though not very architectural example of success; arising, however, to some extent from accidental alteration. The centre is a simple but very large *flat*-ceiling'd room, to which groined side aisles have been added, and the place of the side walls or main roof supports supplied by pillars, between which the sound passes, and is received, intercepted, and distributed by the different facets of the groins, the radiating lines of which probably reach every portion of the congregation.

The Temple Church is even a more triumphant success, and over difficulties almost inseparable from high or elaborate architectural erections. The difficulties in this instance arise from the excessive height of the entrance aisle or hexagonal cloister, and the hard and polished surfaces of the marble columns, encaustic tiles, &c.; but the groined ceiling of the choir and its side aisles, with their numerous bold "interceptions," make ample amends. The side aisles are very little more than half the breadth of the choir, yet the crown of the arches of all three are *on the same level*. This is a sacrifice of architectural proportion in aid of sound very rarely to be met with. It certainly could not have been done with the paltry view of keeping down the expense; yet, had it been raised its due proportion, the radii of its arcs would have terminated at the capitals of the columns, and the exquisitely soft notes now always heard would have been doubtless often lost to the congregation.

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OCEANIC CURRENTS; THEIR CHARACTERS AND PROXIMATE CAUSES.

By THOMAS HOPKINS, Manchester.

OCEANIC currents have been shown to be produced by winds. This has been proved in the great primary currents, such as the north-east and south-east of the Atlantic Ocean, the tropical currents of the Pacific, and the smaller ones in the gulf of Guinea and of Panama.* But when a large body of water is set in motion its inertia will carry it forward after the immediate cause of the movement has ceased to operate. The tropical Atlantic currents flow principally into the gulf of Mexico, and their momentum causes them to be heaped up in that confined sea, from whence the accumulated waters escape and flow through the Florida channel by the force of statical pressure. The motion they receive from this pressure takes them to the great bank of Newfoundland, from whence they are deflected towards the islands of the Azores; and so far all accounts agree respecting the gulf stream. But from this part the movement of the water seems to be so slow as to give rise to various statements respecting the further progress of the current. It is, however, considered to move forward in the open ocean towards the north-western coast of Africa, where it is said to set on the land with sufficient force to be dangerous to ships which approach that coast.

The north Atlantic tropical current is palpably felt, first in about the latitude of 30° to the south-west of Madeira, and, presuming that the north-east trade wind creates this current, water will be borne by the wind from this part of the ocean towards the west,—the surface of the part will consequently be left somewhat below the general level of the ocean. Into this part, therefore, water from adjoining sea would be inclined to flow by the force of gravity, to re-establish the level of the surface; and the gulf stream bringing water near to the part, would be favourably circumstanced for furnishing a constant supply. Assuming this to be a correct view of the case, we have an instance where the force of wind put water into motion, and bore it to a distance, where being stopped, it returned by a circuitous route, and flowed back to the point from whence it had been taken. Now, supposing that wind is the primary force that has put the water in motion, it is to be presumed that, as soon as the moving power ceased to set, the water having been forced to a higher level would be inclined to return to the place from whence it came, either directly or indirectly, provided that no formidable obstacle intervened to prevent it. The flowing of the gulf stream at last towards Africa, is therefore to be viewed as only a natural termination of its course.

The south Atlantic trade wind forces water against the eastern coast of America, and it then runs along the shore of Brazil southward, as far, it is said, as the straits of Magellan. But the impetus given to this body of water by wind, must on the American coast to some extent raise its surface above the natural level of the ocean; and as the Agulhas current which flows round the Cape of Good Hope passes towards the equator, whilst the Brazilian stream is going from it, that stream may possibly, by the force of gravitation incline towards the current. Only slight traces of it however can be found, the distance from Brazil to the Agulhas current being too great to allow a cross current over this wide ocean to become palpable. A north-west wind generally blows from about Rio Janeiro, and this wind may possibly take up the water of the Brazilian stream—force it onward, and commence a new primary oceanic current. The Agulhas current runs from the Indian ocean round the Cape of Good Hope; there is not, therefore, the same reason to suppose that the part of the ocean near the Cape is reduced below the general level that there is in the locality near Madeira. It is, therefore, likely that the Brazilian current is connected with another in the southern Atlantic, and that it may feed the stream that accompanies the prevalent western wind which blows in about the latitude of 40° across the southern Indian ocean to Van Dieman's Land.

The great tropical currents of the Pacific ocean are, by the trade winds, borne westward, that to the south of the equator may be traced across the ocean to Torres straits, the new Hebrides, the Feejee islands, and southward towards the parts where a western wind from New Zealand puts water in motion over the great southern ocean, and impels it against the western coast of America, from which it turns northward, and in due time eastward, becoming a feeder to the great south-east current of the Pacific, making a large though irregular circle.

In like manner, the north-east trade wind of the Pacific ocean forces water across that ocean within the northern tropic, and makes it enter the channels of the numerous islands that lie in the front of the great Archipelago. Meeting with obstructions there, it turns northward about the Philippine islands, and runs towards the Japan Archipelago and the Kurile islands, from which a west wind takes it up and forces it across the northern Pacific to America. Deflected from the land, it here turns southward to rejoin the stream that runs westward across the northern tropic. The water of these northern Pacific currents, therefore makes a circuit nearly as extensive as that of the southern Pacific, in large portions of which circuit the direct force of wind keeps the water in motion.

But, in order to obtain a more clear view of the forces that are in action in these various oceanic currents, it is necessary that we should distinguish more particularly those which are primary from those which are only secondary. The primary currents are put in motion by the force of wind, which by pressing upon the water, impels it forward, and may force it up above the general ocean level, as is seen in the gulf of Mexico; when being abstracted, statical pressure may force it to pass in another direction, as it does through the Florida channel, making it there a secondary current; and with reference to the causes of the various currents that are encountered, it is necessary to distinguish the one from the other. As wind first put the water of the Atlantic into motion, it may be said, in a certain sense, to have been the cause even of its rushing through the Florida channel; but the pressure of wind within the channel is not necessary to give the motion to the water which it there has—it being moved by statical pressure in the gulf of Mexico. That pressure therefore becomes the immediate cause of the movement in the part, and the stream is only a secondary current.

The momentum of the gulf stream carries the water forward along the coast of America to the great bank of Newfoundland, from whence it is deflected to the Azores islands, and throughout the whole of this course it has the character of a secondary current, seeing that in no part of that course is it directly put in motion by wind, but flows in obedience to the impulse given by statical pressure in the gulf of Mexico. From the Azores islands to the coast of Africa, until the tropical trade wind is met with, the movement of the water must also be considered secondary, seeing that there is no continuous wind blowing in the part to create a current of a primary character. In like manner in the southern Atlantic the broad stream which runs from the Cape of Good Hope to Brazil is a primary current created by wind, but when that current, in consequence of the impulse it has received from wind is elevated, and from that circumstance flows along the eastern coast of America, it becomes a secondary current.

Similar remarks will apply to the currents of the Pacific ocean. Within the southern tropic a south-east wind puts the water in motion, and therefore creates a primary current. But, impeded in its progress westward, either by land, sea banks, or other currents, it turns southward, and as a secondary current it passes the Feejee islands and New Caledonia towards Australia and New Zealand, to be in due time put in motion again by the wind which blows from the latter islands towards the west coast of South America; from which coast it appears to rebound and flow towards the beginning of the great south-eastern current, the place from which it took its departure.

The main stream that runs across the northern Pacific to the Philippine islands is a primary current being put in motion by wind; but the impulse thus given to it carries it northward as a secondary current, until taken up by other winds it is carried eastward across the northern part of the ocean to America, to be again impelled as a secondary current towards the part where the primary western stream begins and in which it is lost.

Now, if we wish to know the cause of these great movements of the ocean, and in each case to trace the particular force that puts the water in motion, it is expedient that we should have distinctive names for the different kinds, so as to connect them with the forces that immediately produce them. It has been long known that wind acted on water over which it was passing with considerable force, and it has often been assumed that it had a certain degree of influence in producing some currents, thence called *drift* currents; but in other ocean streams, as no force of wind could be traced, it seems to have been presumed

* See, 'On the Atmospheric Changes, &c.,' p. 376. London: Weale. 1855.

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that there must be some mysterious power in action to create them, and the rotatory velocities belonging to the surfaces of different latitudes have been pointed out as the cause. If, however, we see that wind can put large bodies of water into motion and impel them across wide oceans, it is evident that the forces of inertia and of gravity may then carry the fluid forward; and the precise course that the water must take will depend on the modifying influences it may encounter and the obstacles it may meet. The forms of coasts, the submarine banks and mountains, and deep seas that may lie in its course, may all have their respective degrees of influence in determining the direction and velocity of secondary currents.

Wind then being the prime mover of the water, which may encounter many obstacles, the currents are liable to move irregularly, yet to perform a kind of circuit, and return to the point from which they took their departure. And when this circuit approaches the form of a circle round a portion of the ocean, the central part will be undisturbed by the moving power that has been in action, leaving that centre a comparatively stagnant sea. This is the character of the sea of Sargossa, which is included between say the latitudes of 28° and 36° north, and the longitudes of 30° and 65° west, including the Bermudas islands. In this space the force of wind, neither directly nor indirectly, gives regular motion to water, it being only occasionally disturbed by irregular winds which produce little progressive movement in it. There is also a space similar in character, and produced by similar causes, in the south Atlantic opposite Brazil and outside of the tropic, between the longitudes of say the Meridian of Greenwich and 25° west. In the Pacific ocean the inclosed stagnant sea of the northern hemisphere lies between the latitudes of say 23° and 38°, occupying a large part of the breadth of the ocean. In the southern hemisphere it is outside of the tropic, extending far south and broad. Thus the condition in which these large portions of the two great oceans is found, with reference to motion or rest, is accounted for from the partial action of wind on the surface of the ocean. Where continuous winds blow, the water is put in motion by them, and we find oceanic currents which we call primary. When wind ceases to act in the same way on the water, yet the water continues to move on in any direction, it is carried forward by its own inertia, and is therefore denominated a secondary current. When neither of these influences is in operation, the water is at rest,—the ocean, therefore, remains stagnant, although other water may be in continuous motion around it. The sea of calms in the northern tropical Atlantic, of an irregular triangular form, is undisturbed by continuous winds, because atmospheric vacua operating at certain distances dispose air to flow from the part in three directions, leaving the calm region comparatively undisturbed, the forces which act on the three sides balancing each other. These forces consequently determine the form of this region of calm.

There are many other parts of the ocean where currents are to be found all of which are produced primarily by the same cause, the action of wind on the surface of water, but some of them are accompanied by peculiar modifying circumstances. The Guinea current runs directly into the gulf of Guinea, forced into it, no doubt, by the west wind that blows in the part; it is therefore a primary current. The water is however constantly running into the gulf, and there being none to be seen flowing out, like the Florida current from the gulf of Mexico, it must be raised above the natural level, and we may conclude that it returns to the general ocean by an under current. Water is also carried by wind into the gulf of Panama from the south,—from the open Pacific near the equator, and from California and Mexico, by north-west winds, and the water which is thereby forced into the gulf must be carried above the general water level; but there being no known outlet for it, it must be presumed to be returned to the general ocean by an under current.

The currents in the Indian ocean differ from those of the Atlantic and Pacific, which have land sufficiently elevated on both the western and eastern sides to cause winds to blow towards them from the west as well as the east. But the great area of condensation over the land that affects the Indian ocean is situated far to the north of that ocean, and therefore towards that quarter the strongest winds blow over it. There is, however, a moderate but continuous wind found blowing in the southern part of the Indian ocean towards the west, from Australia to the southern point of Africa. This wind extends in breadth from about 12° to 30° of south latitude, and it takes with it a body of water which passes Madagascar, and which, stopped by the African continent runs southward between that island and the continent through the Mosambique channel in a rapid current. The stream seems to pass from the east round the Cape of Good Hope, and is known by the name of the Agulhas current. The whole must be considered a primary current, except that part which runs through the Mosambique channel. Unlike the double main streams of the Atlantic and Pacific, it seems to be the only oceanic current that runs from east to west across the Indian ocean, and the condensation of vapour that takes place among the high lands of Madagascar, and at the Cape of Good Hope, may be considered as giving birth to it, unless it be viewed as a part of the great ocean stream that afterwards flows across the Atlantic to America.

The strongest winds of the Indian ocean are however the north-west and south-west monsoons. The former blows in the winter over the northern part of the Indian ocean, but does not create any strongly marked oceanic current, until it reaches the islands of the East Indian Archipelago, where however divided currents are found. All writers on the subject speak of the western currents in our winter that prevail in the great Archipelago; and as there can be no cause traced that is capable of putting these waters into motion except wind, we must attribute that motion to the winds of the north-west monsoon.

But the south-west monsoon is the great wind of this ocean, and it appears to be the most violent of the trade winds. It blows from the Mosambique channel when in its full strength, across the whole of the Indian ocean, as well as over Hindoostan to the great chain of the lofty Himalaya mountains, and evidently affects the water over which it passes. Currents are produced by it in the channels between the Maldive islands, and between Ceylon and the main land of the continent. The wind raises the level of the ocean in the Bay of Bengal, and ocean streams run eastward by Sumatra, Java, and Timor, whence they force their way into the Pacific. Thus the monsoon winds of this ocean, both blowing from west in their respective seasons, impel water through the island channels towards the Pacific ocean, sometimes having power enough to turn back the currents of that ocean and to occupy their places, and at other times being driven back themselves by stronger currents coming from the east. These different oceanic currents, running sometimes east and sometimes west, are primary currents, seeing that they are accompanied by winds which evidently put them in motion, and they prove conclusively that winds do create currents of the ocean. The wind according to the season, has superior force on one side of the Archipelago or the other; and generally, when one of the winds displays superior strength, and forces its way against its opponent, an oceanic current follows it and runs through the channels, driving back the weaker stream of water that had been previously flowing from the opposite quarter. And these alternating oceanic currents may generally be traced backwards through the channels, until they are found to be continuations of larger ones in the Indian and Pacific oceans, which have been made to run in opposite directions toward these islands by winds. In the cross and winding channels among these islands the water is sometimes carried forward by the impetus it has received, and may be found as secondary currents flowing in any direction and with various speeds, but the prime moving force may be traced in nearly every case.

We have thus traced a number of the great oceanic currents, extending from the equator to beyond the tropics, distinguishing it is presumed sufficiently between the primary and the secondary. But as we approach the polar regions, both winds and currents have less decided characters. It is, however, abundantly evident that the aqueous vapour which is raised by the sun in warm regions, when by its elastic force sent into the atmosphere, will be disposed to expand and diffuse itself laterally as well as vertically. And some of it will expand into the polar regions, where it will be condensed by cold, warming the air in the locality and causing it to ascend, allowing more air and vapour to flow towards the polar regions as winds of greater or less strength. More decided winds may then blow towards the poles, forcing the water over which they pass to move in the same direction. From accounts given by navigators who have approached the Antarctic ocean, this appears to take place in that part of the world. The atmosphere within a considerable range of longitude, seems to have a movement towards these regions, taking comparatively warm air and much vapour to them, which vapour is often so far condensed as to produce very misty and somewhat warm weather for the latitude. The general mass of the surface of the ocean may

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thus be pressed by wind southward, and raised to a sufficient height to make it flow back as an under current. This seems to be the source of those currents which bring icebergs from the southern polar regions to the Atlantic. We have then presented to our view in parts of the southern hemisphere primary oceanic currents, flowing, though slowly, towards the Antarctic regions at the surface of the water, and secondary currents passing back beneath it. With the imperfect information we possess respecting those parts, this seems to be the most reasonable conclusion we can arrive at. To the south of Kerguelen's land, Crozet Islands, and Sandwich land, the air, as well as the surface water, moves southward, and icebergs indicate that there is an under-current moving in the opposite direction; but from Victoria land within the Antarctic circle, or say about the meridian of New Zealand, there appears to be such an atmospheric, as well as an oceanic current, flowing in an opposite direction, that is to say, northward, as to call for particular notice.

From Victoria land a wind blows towards the north-east across the southern Pacific ocean to Cape Horn, Tierra del Fuego, and Western Patagonia, taking with it a decided oceanic current. No cause for either the wind or current is apparent but elevated land at the southern extremity of America acting as a condenser of vapour to create an atmospheric vacuum, and therefore to condensation of vapour these currents must be attributed. Wind is thereby made to blow from Victoria land to America, and with increased force as it approaches that country, taking with it water which thus becomes a primary current. But, striking obliquely against the western side of America, this current flows on by the Chilian coast, and as the wind does not palpably blow from the south along this part of the coast, the oceanic current may have become secondary, moving from the impulse it had previously received from wind. Soon however a wind begins to blow, and it is so cool as to indicate that it has come from the south; and a current of cold water accompanies this wind by Peru to Guayquil, a part of it going into the Bay of Panama, but the larger portion turning westward to cross the Pacific. Now the ocean stream of cold water that runs by Peru and into the bay of Panama, being impelled by wind in its passage must be considered a primary current, whilst that which turns across the Pacific may be at first only a secondary current, afterwards however to be taken up by a south-east wind and made primary. Thus all the oceanic currents that have passed under view may be accounted for either as primary streams created by wind,—as secondary currents flowing from impulse previously received, or as under-currents consequent on water having been raised by wind above its natural level,—and it becomes unnecessary to search for, or imagine, any other cause for these currents.

In the northern temperate and polar regions, neither atmospheric nor oceanic currents are well defined, there being in those parts a far larger proportion of land than there is in the southern hemisphere, and much of the land having great elevation. In the middle portion of the northern Atlantic ocean westerly winds blow during a considerable portion of the year; south-westerly are also prevalent, extending along the coast of Norway into the Arctic ocean.

From what we have seen taking place in other parts of the world, where winds blow over seas, and put water in motion, we are led to infer that these winds must also to some extent put in motion the water of the northern Atlantic. And the winds are sufficiently prevalent to produce an oceanic current flowing towards the north, corresponding in velocity and continuance with the strength and prevalence of themselves. Water, warm for the latitude, is found on the whole of the European side of the northern Atlantic, and we may conclude that the water found between Norway and Iceland has been brought thither by southern winds. We have seen that in the opposite hemisphere cold water is taken by wind from a part within the Antarctic circle, and borne along the coast of America to the equator, through 66° of latitude, and it arrives near to the equator with a remarkably low temperature, and why should not warm water be taken in the Atlantic from 40° to 80° north, through less than two-thirds of that range?

It has been said that the Florida gulf stream flows into high northern latitudes, and it may be that a portion of the water that had been brought by that stream to the Azores may be there acted on by the prevalent south-west wind, and forced northward. The Peruvian wind seems in that way to take up the cold water which had been brought from the Antarctic regions to Chili, and forces it forward to the equator; and the south-west wind of the Atlantic may equally carry forward some of the warm water of the gulf stream to the Arctic ocean. But according as we come to one or the other of these conclusions, we must consider the movement in the northern part of the Atlantic a primary or a secondary current.

Respecting the Arctic ocean itself, above the latitude of 80°, we have little information beyond that furnished by Parry, when he attempted to reach the north pole by going directly towards it from Spitzbergen, in the month of July. He found rain and wind prevailing; but when he approached 83° of latitude an oceanic current carried him back. That this was a secondary current is very likely, as no wind is known to blow in the direction that the current flowed. But then a question arises,—where are we to look for the primary current that took water towards the pole, and accumulated it there? It is not to the westward of Spitzbergen that search should be made, as water flows thence southward, passing between Greenland and Iceland. And another current runs southward into the Atlantic from Davis' straits, the water from which must be presumed to have come from the polar sea. The accounts we have about the movements of the water about Behring's straits are contradictory; it therefore may sometimes run into the Arctic sea and sometimes out of it, according to the state of the wind. The portion of the Arctic ocean that is situated between Spitzbergen and Nova Zembla seems to be the only one left by which the water that in other parts flows out of the polar sea can be returned to it from the general ocean. Lieut. Maury admits the fact, that a current runs round North cape into the Arctic ocean. In this part, therefore, we may presume that the south-west wind, which is so often found there, by its pressure forces water into the polar basin, creating a primary current that flows to the east of Spitzbergen towards the north pole, and raises the level of the water enough to produce return currents.

We have thus sketched many of the known currents of the ocean, and shown that a number of them can be traced to the direct action of wind; while those which are not acted upon immediately by it, are produced indirectly through its action. But there is reason to presume that currents in the ocean may be found which cannot readily be traced, either directly or indirectly, to wind; and these, in each case, will require special consideration and enquiry. It is not necessary that any of such should be here named, but we may be allowed to advert to some circumstances that may give birth to such currents in various parts of the ocean.

Continuous winds may put water into motion to great depths, and obstructions to its onward movement may accumulate it, until it makes its way through some side channel, or flows back as an under-current. In such a case the statical pressure of the water will produce a stream with velocities varying at different depths. Friction against the bed of the sea will retard the flow in the lowest part, and movement of the atmosphere may impede the motion of the surface water, while the statical pressure will act with the greatest force in the deepest parts; and it will follow that at some considerable depth the current will be the most rapid. But the bed of the ocean is known to be uneven, some parts being very deep; others are less deep, or have narrower channels, whilst some are found to be shallow banks. Now, an under-current may have to pass over parts having such various depths and breadths, and the velocity of the current will vary accordingly. It may flow into a deep part, where it may mix with a large store of water, and for a time disappear, to show itself afterwards at the surface, in a narrow channel, or on a shallow bank. But it is sufficiently evident that all such currents as those last named may have received their motion primarily from wind. Various surface as well as under currents may also encounter and modify each other in all conceivable ways.

The water of the ocean is sometimes put in motion by occasional winds, when local and temporary currents are created. These, it is evident, must more or less interfere with the more permanent, and they do really disturb them to a considerable extent in some places. In certain localities, local storms are not uncommon, and winds blow sometimes in one, sometimes in another, direction; but each of these winds may, for a time, create a primary current of greater or less strength, which in its turn may produce a secondary current, modifying those which are more permanent, and contributing to the creation of that great irregularity in currents that is often found in channels and shallows among islands.

We have so far treated only of oceanic currents that have been put in motion by wind. There are, however, other important movements in the mass of water that covers so large a portion of the globe. Tidal action, though little felt in the open ocean, is very

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important in shallow seas and confined channels; and the flow of the tidal wave may modify the oceanic currents of which we have been speaking. The different specific gravities of water, resulting from unequal temperature and degrees of saline saturation, will also have their effects; but these are not likely to be very striking among the more powerful forces that are in action, excepting under special circumstances, such as those existing at the junction of the Mediterranean sea with the Atlantic ocean.

When, however, treating on the subject of oceanic currents, in connection with their causes, we cannot avoid alluding to an influence to which great importance has been attached. Water, like the atmosphere, has been supposed to flow from the equator towards the poles, and to return to the equator, having its direction altered through the various rotatory velocities of the surface of the globe in different latitudes. This idea received a certain countenance from both the Atlantic and Pacific main currents, the water in them appearing to be left behind within the tropics, and to take its high rotatory velocity with it as it passed from them; it being known and admitted that if a fluid passes from a part which is moving with a certain rotatory velocity to another part that is moving at a different speed, the fluid will be affected, and its motion modified by the different speeds of the surface over which it is passing. But water presses on the bed of the ocean with a force proportioned to its weight, and this force is sufficient, at the speed of our oceanic currents, to enable the land to take with it the water that is pressing on it with its own rotatory velocity, or with so small a difference as to be inappreciable except by the labours of the mathematician. There are also many ocean currents that move freely in opposition to the rotatory motion of the earth, proving that that motion produces little effect on them.

The general conclusion, then, at which we have arrived is, that moving air, pressing on the surface of the water of the ocean, puts the water in motion, and in that way creates oceanic currents; which, whether primary or secondary, surface or under-currents, constitute the great currents of the ocean.

NEW WESTMINSTER BRIDGE.

(*With an Engraving, Plate* XXIII.)

In accordance with instructions from the Chief Commissioner of Works and Public Buildings, Mr. James M. Rendel, C.E., and Mr. James Simpson, C.E., have made their report on the works of New Westminster Bridge, now in course of erection from the designs and under the superintendence of Mr. Page, C.E. They report:—First. That the liabilities for works incurred on account of the new bridge have been, up to the present time, 85,009*l.* 1*s.*, of which sum 26,096*l.* 11*s.* 1*d.* are on account of works in the foundations, and 52,832*l.* 19*s.* 6*d.* for materials and plant delivered. The balance is for contingencies of various kinds.

Second. That the proportion of the foundation works of the entire bridge executed may be regarded as equal to about one-fourth of the whole, and that about one-third of the iron-work of the superstructure is delivered, and more or less fitted together on the Commissioners' Wharf at Battersea.

Third. That the completion of the first section of the new bridge will demand at least eighteen months from the time of active resumption of the works.

Fourth. That the time necessary for the completion of the second section of the bridge cannot be estimated at less than four years from the opening of the first section; that the cost of completing it cannot be estimated at less than 200,000*l.* and that the probable cost of suitable approaches will be 384,800*l.*, making a total of about 584,800*l.*, or say, 585,000*l.*; of which, however, 70,000*l.* are for property already belonging to the Bridge Estate, and 170,000*l.* for clearing away the block of houses on the south side of Bridge-street.

Fifth. That the original scheme is defective in many of its details, more especially in the construction of the piers below low water.

Sixth. That it will be prudent to retain the site of the bridge, and if a width of 85 feet is considered necessary, its general arrangement; but that the details of the design should be modified; and that, in particular, the piers and abutments should be of solid stone, carried down deep into the London clay.

Seventh. That the probable further cost of the bridge on such modified plans would be—For the bridge, 269,000*l.*; for a temporary bridge, 35,000*l.*; for the approaches, 384,800*l.*; total, 688,800*l.*

Eighth. That the present is a most favourable time for considering whether, instead of concentrating on the approaches to this bridge the large traffic which alone could justify the width proposed for it (85 feet), it would not be more to the public advantage, both presently and prospectively, to build, as so frequently suggested, a second bridge, 60 feet wide, from the Horseferry-road across to Church-street Lambeth, reducing to the same width the new bridge at Westminster, and avoiding the cost of a temporary bridge. That this bridge should be founded deep in the London clay on solid stone piers, with, on account of the lowness of the streets, an iron superstructure and five arches, the clear water-way and headway being the same as Westminster.

Ninth. That such bridge at Lambeth may be built in four years, and at a cost of—For the bridge, 240,000*l.*; for its approaches, 175,000*l.*; or, in all, 415,000*l.*

Tenth. That a bridge 60 feet wide at Westminster, might be constructed, making the same allowance for plant and materials already belonging to the commissioners, and for the materials of the old bridge, as in the case of the 85 feet bridge, for 218,000*l.*; and that its approaches might be obtained for the sum of 265,000*l.*; making the total cost of the bridge from the present time, 483,000*l.* This sum, however, includes 22,000*l.*, the value of property already belonging to the Bridge Estate, and 170,000*l.*, the estimated value of the property on the south side of Bridge-street.

Eleventh. That the saving of expense by the construction of a bridge 60 feet wide at Westminster would be—For the bridge, 51,000*l.*; for the approaches, 119,800*l.*; or, in all, 170,800*l.* And that this sum, together with the saving effected by the avoidance of a temporary bridge, which has been estimated at 35,000*l.*, placed to the credit of the Lambeth bridge, would reduce its cost from 415,000*l.* to, say, 210,000*l.*

The new bridge was designed to occupy the site of the present, but to be of double the width, the addition being wholly on the south side, with a view to the completion of that half before the old bridge was removed; thus avoiding the necessity for a temporary bridge pending the construction of the new bridge on the site of the old one.

Mr. Page's scheme is devised with a view to the avoidance of the use of cofferdams or caissons for founding the piers and abutments. This is done by forming the piers below low water of a series of wooden piles, surrounded by a sheeting of cast iron, the space inclosed by this sheeting being filled in with concrete.

With a view to prevent the cast-iron piles being laid bare by the scour of the river beyond a fixed limit, namely, three feet below low water, it is proposed to surround them up to that height with a bank of concrete; and in order to guard the piers, masonry, as well as cast-iron piling, from accident by the fouling of barges, steamers, or otherwise, they are to be protected by floating fenders or booms.

That the mode of forming these important portions of the piers and abutments may be clearly understood, we have annexed an Engraving to illustrate the following detailed description:—

Under each pier there are to be driven 145 elm piles, chiefly in rows of three and five alternately. All these piles are intended to carry an uniform load; and to obtain the degree of resistance which is regarded as sufficient for that load, they average 30 feet in length, and are driven about 17½ feet into the solid London clay, which is here said to lie at a depth of from 28 to 32 feet below Trinity high water, with an uniform surface.

The cast-iron piles are, as will be seen by the engraving, of two kinds; namely, hollow round piles, 15 inches diameter, with two grooves cast in them opposite each other, and plate or flat piles, cast with flanges to strengthen them. These two kinds of piles are placed alternately, the plate piles being driven down after the round piles between the grooves, described as cast in the latter; and thus it is proposed to enclose within an iron case, not only the wooden piles and concrete deposited inside the piers, but also the bed of the river, gravel and clay, to the depth to which the plate piles are driven; that is, to 21 feet below low water.

The next operation is the removal of the loose mud and sand from the enclosed space down to the gravel. The opposite cast-iron piles are then united by strong wrought-iron tie-bolts in two tiers, and this is done by the aid of the diving dress: the next and final step in the completion of the work up to low water, is the deposit of the concrete between all the iron and wood piles from the gravel up to that level. We should, however, explain that the heads of the cast-iron plate piles are driven 6 feet below

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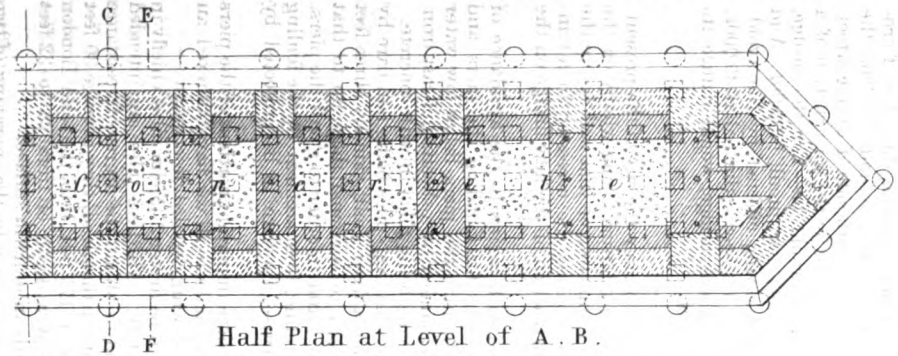
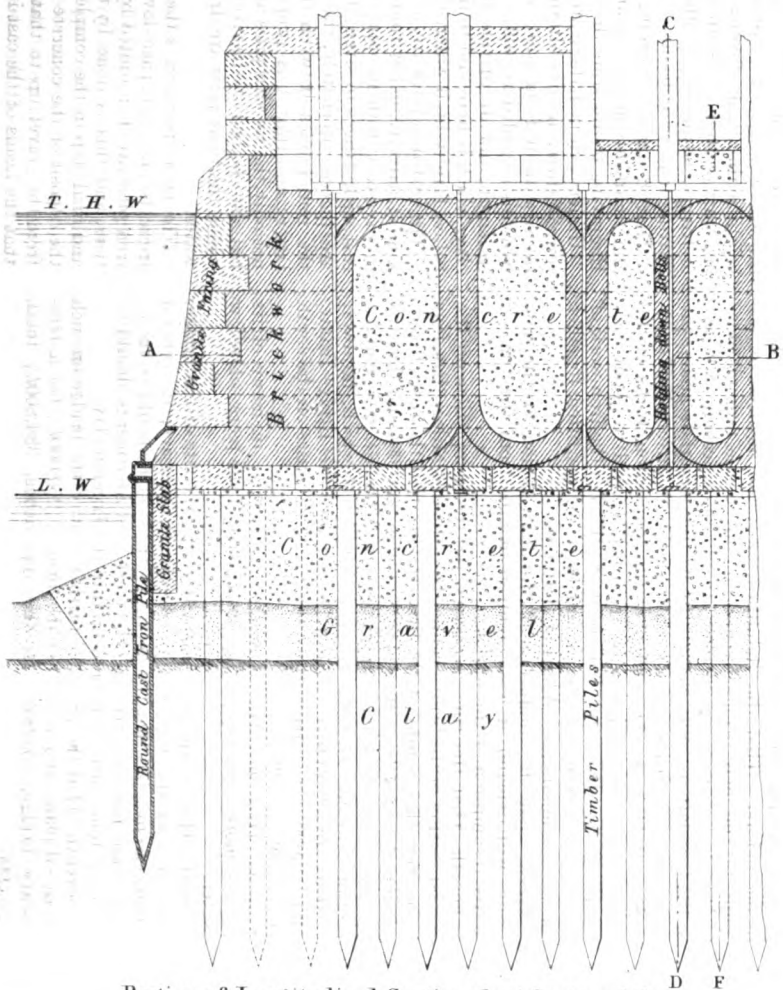
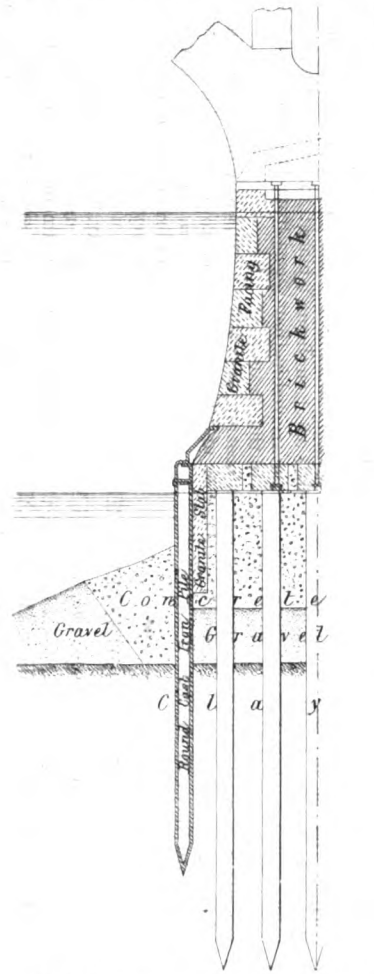
DETAILS OF ONE PIER OF WESTMINSTER BRIDGE.



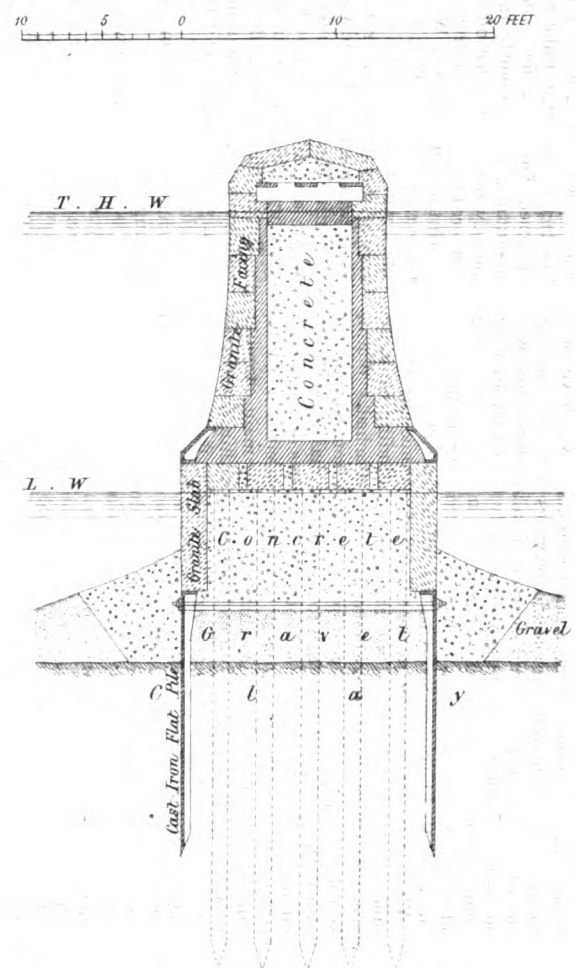
Half Plan at Level of A. B.



Portion of Longitudinal Section thro' Centre of Pier.



Half Transverse Section on line C.D.



Transverse Section on line E.F.

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low water, while those of the round piles stand 1 foot above low water. The spaces thus occasioned in the iron casing are filled up with granite slabs 18 inches thick, the lower end of the slabs resting on the head of the plate piles, and the upper standing 2 feet above low water, ready to receive the first course of masonry.

These several works completed, the wooden piles are cut off to an uniform level of 6 inches above low water; a block of stone 18 inches thick and 4 feet area is solidly bedded on the head of each bearing pile; the spaces between these blocks are filled in with concrete, and the whole surface of the piers, including the granite slabs, is levelled off to the height of 2 feet above low water to receive the first course of masonry.

Above this first course of masonry, which is of solid granite, 2 feet thick, the piers are faced all round with granite, backed by brickwork; the latter not solid, but having cross walls about 2 ft. 3 in. thick in the line of each of the iron ribs of the superstructure. The spaces between these cross walls are filled with concrete.

The masonry of the piers is terminated 2 feet above Trinity high-water line, from which level the iron superstructure of the arches is commenced.

There are to be seven of these arches, namely, two next the abutments, on either side of the river, of 94 ft. 9 in. span; two next these, of 104 ft. 6 in. span; two next the last, of 115 feet span; and a centre arch, of 120 feet span.

Each is to consist of 15 ribs, and each rib is formed in five segments.

The centre segment, except in the external ribs, is to be made of wrought iron, and varies from 40 feet to 52 ft. 3 in. in length; from 22 inches to 28 inches in depth in the middle; and in sectional area from 47 to 60 square inches, according to the span of the arch.

The two external or face ribs are intended to be wholly of cast-iron, and to otherwise differ from the internal ribs, with a view to their being formed in the ornamental character of the general design.

The roadway is to be carried on thin wrought-iron plates, bent or buckled to increase their stiffness, in the manner lately patented by Mr. Mallett of Dublin. The plates cover the whole of the superstructure.

Over the plates there is to be laid a kind of bitumen concrete, to make an uniform and water-tight surface for the carriage and two foot pavements. The latter are to be formed 15 ft. wide each, and flagged with "Hopton Wood" stone; the former is to be 53 feet wide, and paved with "Mount Sorrel" granite, 4 inches thick, set in bitumen. The roadway over the abutments of the bridge is to be formed of 12 inches of concrete, covered with 3 inches of asphalte, on which the granite paving is to be laid.

It is intended to divide the carriage-way by a fence, extending from end to end along its centre, into a going and a coming road, and in each division there is to be a tram, partly of granite and partly of iron, for the heavy traffic.

It is intended to dredge the channel of the river out between each arch to a regular curve, commencing at 3 feet below low water at the piers, and laying bare the clay in the centre, which would give a low water depth at that point of about 12 feet. Further, it is intended to dredge out the gravel down to the clay, all round the piers, for a width of about 6 feet, and to fill in the space so dredged with concrete.

Messrs. Rendel and Simpson are of opinion that the permanent character of the bridge will depend on the soundness of the foundations below low water. That the strength of each part is liable to suffer by the failure of any one, and in especial the fracture or the improper execution of any portion of the outer cast-iron casing might be productive in the end of very serious results. And, supposing the principle on which these foundations are constructed to be a sound one, it is one that peculiarly requires a cofferdam; for this alone would ensure that careful supervision which is demanded by a class of work dependent for its permanence on its faultless execution. They think it probable that the bottom of the river will not retain the peculiar form intended to be given to it: should this be the case, the concrete banks round the piers would in no long time be broken up, and the piers be weakened, first, by the increase of their unsupported height, and, secondly, by the diminution of the depth and solidity of the material through which the piles of which they mainly consist are driven.

Messrs. Rendel and Simpson regard the efforts of the engineer of the new bridge to avoid the cost of a temporary bridge and of cofferdams as laudable, and that they exhibit a marked disregard of personal trouble and anxiety. But they state that, looking to the changes which have taken place in the bed of the Thames, through London, since the removal of old London Bridge, and to the well-known effect which these changes have produced on the foundations of the several bridges, and especially to the great disturbance which the bed of the river at the site in question has undergone in the various attempts to keep up the old bridge, they do not feel that the present, or any plan which does not comprise solid stone piers and abutments, carried down deep into the London clay, can be regarded as possessing a "permanent character." They are further of opinion that this is a case specially demanding the aid of cofferdams, not only that the site of the new piers may be laid open to view, as well as their foundations be laid at a sufficient depth, but also for the better, cheaper, more expeditious and safer removal of the arches and foundations of the old bridge; a matter important alike to the safety of the piers of the new bridge, and the early improvement of the navigation of the river.

They are also of opinion, that the saving of the cost of a temporary bridge is not a sufficient compensation for the trouble, delay, risk, and extra cost consequent on the construction of the bridge in even two sections as now proposed, and the first in such close proximity to the old bridge. Should the present design be prosecuted, they recommend that the foundations, masonry, and iron superstructure, except the plates which carry the roadway of the two sections, should be built entirely independent of each other, so as to reduce the consequences of unequal settlements in them to the least possible evil.

Evidence before the Select Committee.

The select committee appointed to inquire into the state of Westminster-bridge have had several sittings, and have examined Mr. Page (the engineer of the Office of Works and the author of the plan), Mr. Rendel, Mr. Simpson, Mr. R. Stephenson, Mr. Fowler, Mr. Hawkshaw, and Sir B. Hall.

The general tenor of the evidence is against the mode of construction of the bridge, as not being likely to render the structure permanent; and it is probable that the committee will report to the house that it is not advisable to proceed further with the bridge according to the present plan. Sir B. Hall, in his evidence, gave a history of the manner in which his attention was first called to the state of the bridge, and the steps he took to arrive at the truth. After Mr. Mare's bankruptcy, on the 25th of September last, the assignees proposed to carry on the contract, but they soon got tired of the work, and wished the Chief Commissioner to take it off their hands. This, however, he did not at first feel inclined to do. On the 7th of January last, a gentleman, whose name is not mentioned, called at Sir B. Hall's private residence, and directed his attention to the state of Westminster-bridge, as not satisfactory. The Chief Commissioner the same day put himself in communication with Mr. Rendel, and afterwards associated with him Mr. Simpson. These gentlemen were then directed to institute a searching investigation as to the character of the works and the principles upon which the bridge was being constructed. Under their advice the works were stopped in March, and according to their report, the wisest course will be to put up with the present loss, and to begin the work anew. Mr. Rendel, Mr. Simpson, and Mr. R. Stephenson severally condemn the principle upon which the piers are being constructed as not being of a permanent character, and being likely to decay and subside. They consider that it is very doubtful, to say the least of it, to erect the foundation of these piers without the use of cofferdams. Mr. Page's proposition was that rows of wooden piles should be driven into the London clay, to be protected on the outside with cast iron piles. The interstices to be filled with concrete; on the top of these piles was to be laid a block of granite, two and a half feet thick, upon which the superstructure would be built. The three engineers object to this mode of construction, first, that the pressure of the superstructure upon this base would be unequal, that settlements would soon take place, and the bridge crack. They object, further, because it has been found by experiments that cast iron is much injured by the action of the salt held in solution in water, that the iron becomes honeycombed and decays. The iron would be wasted away, and with it would go the concrete from the foundation. Again, it appears that sufficient provision had not been taken for the increased flow of water when the Thames is embanked, which, ere long, must be effected. This it is estimated, would lower the bed of the river some five or six

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feet, by scouring away the gravel. Mr. Rendel and Mr. Simpson go so far as to state their opinion that when the Thames is embanked, so great will be the increased flow, that ere long the London clay would be exposed, which lies about twelve feet below the gravel. Should such an event occur, and the bridge had been constructed on the plan proposed by Mr. Page, the probability, according to Messrs. Simpson, Rendel, and R. Stephenson, is that the bridge would soon be rendered unsafe. They further disapprove of the plan of building the bridge in two sections, which, they are of opinion, would render the construction not only very difficult, but would be attended with considerable risk. Mr. Stephenson, perhaps the greatest authority on the erection of bridges we have, observes that in the plan for the iron portions no allowances have been made for the expansion and contraction of the iron by heat and cold. He pointed out that the Britannia-bridge in very hot weather sometimes expands as much as four inches, and that, if proper allowance had not been made, the work would have been a failure. As an instance of the necessity of such allowance being made, he instanced the iron bridge at Sunderland. This bridge is wedged in between two abutments of masonry, or rather rock, and from the expansion the bridge has become fractured, and is now in a very precarious state. The same may be said of Southwark-bridge; it rises and falls every day. Serious apprehensions were entertained at one time, when it was first opened, of its being permanently injured, but it is so enormously strong, that it has resisted that effect. But any one passing over the bridge can see by the footpaths how distorted the pavements are by the expansion and contraction of the iron. The new railway bridge at Rochester expanded four inches one day last month. With all these facts before him, it seems strange that such an oversight should have been made by the engineer. Fortunately, however, not much harm has been done, as none of the iron work has been put up.

On the other hand, the testimony of Mr. Fowler and Mr. Hawkshaw are favourable to Mr. Page's plan, but from the reluctance with which the three first-named engineers gave their evidence, and from their very high standing and reputation, the committee will naturally hesitate before they refuse to report adversely to their opinions.

There was one point, which came out rather unexpectedly, but which is of considerable importance to the public, and that is the increased dangerous condition of the old bridge; it was bad enough before, but now that the new bridge has been commenced a considerable portion of the old foundation has been cut away, and when the works were stopped no measures were taken to meet this contingency.

Report of Committee.

The report of the committee was presented to Parliament on the 23rd ult. They state that they have examined Messrs. Rendel and Simpson, and also Mr. Stephenson, Mr. Hawkshaw, and Mr. Fowler, all civil engineers. The two last-named were selected by Mr. Page, who was also examined. A written statement was also put in by Mr. Page, who had every opportunity of suggesting such questions as he deemed fit to the witnesses under examination.

Application was made by letter on the part of the city of London to be heard on the subject of the headway under the bridge. The late period of the session determined the committee to confine their inquiry to the proposed mode of construction of the piers, their sufficiency to bear the weight to be put upon them, and how far such a construction can be considered permanent.

The description of the construction of the piers and plans thereof will be found in the report of Messrs. Rendel and Simpson, given in a previous page

The committee are satisfied that the proposed piers are of strength amply sufficient to bear the weight proposed to be placed upon them; that the piers will be secure so long as the iron casting remains sound; that the iron casting can be replaced whenever it may decay or be destroyed; that such a mode of construction is less permanent and secure than granite piers, founded deep on the London clay by means of coffer-dams; but it is less expensive, and can be carried out in a shorter period of time, and causes less obstruction to the navigation of the river. The changes that have taken place in the bed of the river and in the flow and ebbing of the tides of late years ought to have due consideration before determining the mode of construction and the headway under the bridge. The witnesses examined before the committee differed somewhat in opinion as to the amount of any probable future change in these respects.

The report of the select committee on Public Offices, presented to the house during the sitting of the committee, contemplating extensive changes in the immediate neighbourhood and approaches to Westminster-bridge, having been brought to the notice of the committee, they are of opinion that, subject to the consideration of responsible professional advice to be obtained by the First Commissioner of Works, as to the security of the old bridge, the further progress of the works of the new Westminster-bridge should remain suspended until the government have had an opportunity of considering and deciding on the advice to be offered to Parliament upon this last subject, when the site of the new bridge might be reconsidered in connection with any general plan of alteration and improvement of the neighbourhoods as well as the all-important subject of the headway under the new bridge.

The committee finding that upwards of 50,000*l.* having been already expended, subject to the foregoing remarks, subject also to some of the modifications and alterations suggested by the witnesses, are of opinion that the plan proposed might have been carried out.

THE PUBLIC OFFICES.

THE report of the select committee on Public Offices has been presented to the House of Commons. It refers to the inconvenience which now results from the various public offices being located at long distances from each other, and, as an instance, refers to the War department, where it appears, exclusive of that branch of the business which is transacted at the Horse Guards, under the direction of the Commander-in-Chief, the business of the War department is carried on at no less than ten different places, having separate establishments of clerks and officers, amounting altogether to 498, and varying in number from two to one hundred and eighty in the several establishments. The committee, therefore, recommend, both as regards economy and efficiency in the transaction of business, that there should be a concentration of the public offices, and that such concentration should be effected in the immediate vicinity of Whitehall and the Houses of Parliament.

It appears by the evidence that the houses now occupied as offices for the public service (and which are held on lease) represent a rental of 22,000*l.* per annum, and that the same accommodation would be afforded by public buildings, three stories in height, and occupying an area of 171,638 square feet, exclusive of open spaces. But if the branch of the Admiralty now conducted at Somerset House should be removed to Whitehall, an additional space of 42,600 square feet will be required for that purpose; and, looking to the continued increase which appears to take place in the business transacted by the public offices, of which some remarkable instances are given in the evidence, it may be regarded as a wise economy to make some provision for additional buildings which may possibly be required for the public service within a very limited time.

With reference to the property required to be taken, the report recommends that the area should be that bounded by the back of Richmond-terrace; the north front of the Irish Office and Downing-street on the north; New Palace-yard and Great George-street on the south; the River Thames on the east; and St. James's Park on the west. All the property comprised within this area can be obtained. The above space includes, with the buildings in Downing-street, 825,275 square feet, one half of which it is calculated must be devoted to open spaces, and the other half to new buildings. Of this area 171,638 square feet will be required for the offices before alluded to; 42,600 square feet for the accommodation of the Admiralty business now conducted at Somerset House; and 151,535 square feet for the other offices; leaving, for additional buildings likely to be required, 46,864 square feet. In this space of 825,275 square feet is included a portion of ground amounting to about 70,000 square feet, which it has been stated to the committee will probably be required for approaches to Westminster-bridge and for throwing open Westminster Hall to those approaches by taking down the south side of Bridge-street. For this space the sum of 250,000*l.* has been included in the estimate, which is as follows, viz.:— The total sum required for the purchase of the ground above enumerated will, deducting this 250,000*l.*, be about 1,250,000*l.*

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To this sum must be added the cost of erecting the proposed buildings, which has been estimated at 1,000,000*l.* On the other hand, however, there is to be deducted of course a capital corresponding to the rental of the houses above referred to, viz.:—22,000*l.* per annum, and it should also be borne in mind that the portion of Somerset House now occupied by the Admiralty will be set free for other purposes. An opportunity will also be afforded, without incurring any additional expense, to make a great opening from Whitehall to Westminster Abbey, by erecting the new buildings on each side of such thoroughfare.

The report further recommends that it would be an economical arrangement to acquire at the same time the property between the north side of Great George-street and the Broad Sanctuary, together with the west side of Princes-street. The committee also recommend, in case Parliament should sanction the acquisition of the above properties, that the design of the different public buildings to be erected on the proposed site should be submitted to public competition.

Such is the report which Parliament is called upon to sanction. Hitherto it has been the practice for government to do things piecemeal, so that they never get a perfect whole; but now there is a place before them which will not only be a vast improvement of the metropolis, but eventually be by far more economical than the present system of taking second-rate houses on repairing leases, and fitting them up for the public service at a cost greatly enhanced by the unfitness for the purpose required. The sum of 2,250,000*l.*, or rather 1,600,000*l.*, because the capitalised value of the houses now erected will have to be decucted, is certainly a large sum, and it will perhaps make financial reformers stare; but what is it in comparison with the advantages to be derived to the public revenue, and the improvement of this portion of the metropolis? If the cost was thrown over, say sixty years, the annual amount would scarcely be felt. Indeed, a per centage of the enormous sums annually wasted by Parliament would more than cover the annual cost. The approaches to the new bridge might be made magnificent, for there would be plenty of space. That expensive toy, the Palace at Westminster, Westminster Hall, and Westminster Abbey, would be well thrown up, and then from the Horse Guards to the House of Lords the magnificence of the locality would not be approached by any portion of any city in Europe. Should Parliament adopt that portion of the report which recommends the purchase of the land, and the erection of the buildings, they ought to adhere to that portion of the recommendation which advises that the design should be thrown open to public competition, not only to the architects of England, but also of Europe and America.

ARCHITECTURAL IMPROVEMENTS OF LONDON.

No. IV.

In our last paper we described the extensive premises of Messrs. Munt, Browne, and Co., in Wood-street, as illustrating the peculiar style of the French Renaissance. We shall now notice a structure of some importance situated in Lombard-street, and erected for the Colonial Assurance Company, in which the architect, Mr. E. l'Anson, has adopted the same style, with considerable success. The street frontage of this edifice measures 37 feet, and the height to the top of the cornice at the eaves about 60 feet, above which are five dormer windows in the roof. There is an entrance at each end, formed in two broad piers of red granite, between which is a large plate glass window subdivided vertically by pillars, also of red granite, polished, having a handsome appearance. The substructure is entirely composed externally of Portland and Anston stone, the latter being used for carvings, which have been worked in position, in the manner pursued in Paris, which is found to have many advantages over the old plan of carving the subject on the "banker," and fixing it afterwards. In this instance, as in the building in Wood-street, previously noticed, the usual Palladian system of columns or pilasters in vertical arrangement, is entirely abandoned. A somewhat singularly designed cornice is carried across the elevation under first-floor windows, in the centre of which is projected a balcony. The three upper stories are embellished in the usual Renaissance manner, the windows having no facias to their architraves, which are composed only of an ogee moulding and fillet. The sills are supported by plain blocks or trusses, and between the upper ones are pilasters with enriched capitals. The terminating cornice at the eaves is bold and simple in design, and remarkably well proportioned, a cavetto being used as the upper member instead of the usual cyma recta, and which produces more shadow. There are plain moulded modillions introduced under the corona, over which are lions'-heads. The dormers in the roof are appropriately embellished, as also the chimneys, which are of red brick with stone mouldings, and are not disfigured by the questionable terminations in zinc and other materials which disgrace many of the buildings in the metropolis. The structure, as a whole, is a very clever specimen of the style adopted, and we should rejoice to see some of the adjoining proprietors follow in the same praiseworthy spirit, and so improve this important and advantageous portion of Lombard-street as to render it worthy of association with the Royal Exchange, the Bank, the Mansion-House, and other large edifices by which it is surrounded.

At No. 106, Wood-street, the business premises of Messrs Hugh Jones and Co., wholesale milliners, we have an example of what may be effected in an inconveniently narrow street, where space and light is of the highest importance. In the elevation of this structure the architect, Mr. Burton, of Charlotte-row, City, has eschewed all extraneous projections. The windows, up to the fourth story, have no architraves, but are recessed within piers, which are terminated by a cornice of elegant and imposing character, embellished with trusses in pairs at each end, between which heads are inserted from which depend festoons of fruit and flowers, terminated by swags which extend 12 inches down the piers, the plain faces of which are rendered more expressive by a species of finely-developed frosted work carried uninterruptedly from the bottom to the top of the piers. The windows above the cornice just described are recessed within rusticated piers of the ordinary design, and, like the lower range, have no architraves. The upper cornice is rendered unimportant by the want of sufficient projection, and is terminated by a Greek ovolo which appears somewhat *mal-àpropos*. Panels are inserted between the bottoms and soffits of the lower windows filled with carved pateræ, and in the centre panel over the first-floor is one composed of foliage of bold design and execution, with the date of the building (1854) in the centre. The street-front is constructed of stone up to the main cornice, and is carefully executed both as regards the plain and carved work. The upper portion above the cornice is brick covered with Portland cement, to resemble stone. It may be remarked that the horizontal joints in the stone piers between the lower windows, for the sake of constructive propriety should have been more plainly indicated, in order to avoid the idea of their being composed of wood or iron. Notwithstanding a few drawbacks, the façade of this edifice comprises a very judicious and ingenious example of what can be accomplished to combat the inconvenience of a narrow street and a crowded thoroughfare.—Another specimen somewhat similarly treated, but much plainer in its decoration, may be observed on the western side of Finch-lane.

Whilst noticing the Renaissance style, we may direct attention to one of the most important mansions which has been erected in the metropolis during the last few years. This is the residence of Mr. Hope, in Piccadilly, upon which structure no expense has been spared by the wealthy proprietor. It is entirely constructed externally of stone, and the interior fitted up in the most magnificent style. Although exception can be taken to some portions of the design, the whole of the workmanship, particularly the stone carving and iron railing in front, are executed in the most admirable manner, and with a sharpness and elaborated manipulation seldom to be met with. Here, again, the regular system of Palladio and his followers is rejected, neither columns nor pilasters being introduced in the composition. A striking deviation in reference to design is, that the most prominent cornice is not introduced at the eaves of the roof, but runs across the façade above the windows of the third story, whilst a comparatively insignificant one terminates the elevation surmounted by pedestals carrying urns with balustrading between them. The roof has pediment-headed dormer windows, which, with the various chimneys, are appropriately decorated with mouldings. The windows of the first and second floors are divided into two general lights by stone transoms, the first of which have segmental-headed pediments, the tympanums of which contain sculptured boys holding shields. The piers between the windows are pierced by panelling, the grounds of which are filled with polished red granite. The spaces between the soffits of the windows and the upper cornice are also similarly panelled. The entrance to the mansion is by an elegantly proportioned Doric portico in Down-street, admirably executed in stone.

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At the corner of Threadneedle-street and Old Broad-street we have in two buildings an opportunity of contrasting the severe, chaste, and classic development of Greek architecture, with that of the more ornate and luxurious style of the modern Italians. One of these examples consists of what is now used as the City Bank (formerly the Hall of Commerce), and the other comprehends the offices of the Imperial Insurance Company. The former is built upon the site originally occupied by the French Protestant church, which was purchased by the late Mr. Moxhay. The front elevation is entirely of stone, and, with the exception of the large bassi-relievi frieze, was executed by Mr. Sharp. This sculptured frieze was by the celebrated Watson, one of the most promising workers in the plastic arts which England has produced in our times, and who died, neglected by our apathetic patrons of the fine arts, without, we believe, having received a single commission of any consequence during his brief and unrequited career. The conception of this sculpture is at once bold, original, and effective, artistically grouped, and worked out with a vigour surpassing Flaxman, but not perhaps equal to him in severe classic feeling. It is an allegorical representation of Commerce, Peace, and Industry, Astronomy, Navigation, Civilisation, and Liberty granted to the Slave. The plaster decorations of the interior are very bold and elaborate, and were designed and executed by Mr. Charles Arnold, sen., the eminent modeller in that peculiar style of early Grecian art so much distinguished by the purity and delicacy of its formations.

The office of the Imperial Insurance Company is also of stone, and does not contrast unfavourably with its Greek neighbour. A considerable amount of decoration is bestowed upon it, particularly at the chamfered corner of the edifice in which the entrance is inserted. Above the doorway is a large window on the first-floor, adorned at its jambs with Corinthian columns and pilasters, and surmounted by a segmented-headed pediment, over which a panel is inserted, decorated with foliage, and a cornice with a coat of arms, the supporters of which are two female figures each holding a cornucopia, and at the foot are a lion and unicorn recumbent in alto-relievo. The façades have the usual characteristics of the style, as regards the window and other dressings, and are surmounted by balustraded parapets with vases upon their intervening pedestals. The ground-floor story is successfully treated, somewhat in the manner of that in the Strand front of Somerset-house by Chambers, the apertures for the windows being formed of a series of semicircular-headed arches, and the key-stones embellished with heads admirably carved. The piers between these windows are decorated with vermiculated work, and the whole has a very good effect.

Opposite this building, on its Threadneedle-street front and forming a portion of Finch-lane, is another new and extensive structure erected for the business of the Bank of Australasia, in a somewhat similar style, but wanting in that refinement of design, harmonious proportion, and finish in its details and carvings, which we ever wish to see developed. It consists of four stories above the level of the ground. The ground-floor is occupied for the immediate purposes of the bank, with chambers above and an ample basement below. The entrance doorway is somewhat imposing, with three windows at the side, divided from each other by channelled rustic work in courses of unequal widths, in very questionable taste. Over the soffits of the two largest windows are emblematic carvings entwined by wreaths of laurel. The first-floor has windows with segmental-headed pediments supported by plain moulded trusses, separated by panelled piers filled with carvings of fruit and flowers suspended from lions' and dolphins' heads. The third-pair windows are surmounted by triangular-headed pediments, and the upper ones have plain segmental heads with merely architraves round them. The façade is finished at top by a cornice having Ionic modillions supporting its corona, and above the cornice is a very plain, unpretending parapet. Resting on the intermediate cornice above the first-floor windows, pilasters are arranged between them, extending to the architrave of the upper cornice. Considered, as a whole, this structure scarcely contains one redeeming quality to raise it above mediocrity, for a general want of harmony pervades throughout; the details of the window dressings are poor and flimsy in the extreme; whilst the entrance doorway and main cornice are disproportionately heavy, and the carvings vulgar in design and coarse in execution.

Adjoining this building in Threadneedle-street are the premises occupied by Mr. Banister and Messrs. Heseltine and Powell, which also, we regret to say, cannot be spoken of in terms of commendation, the design being faulty and the details wanting in boldness and general good effect. The upper cornice of the elevation is somewhat singular in its treatment, being divided longitudinally into four breaks, which project over the pilasters between the windows, and are supported by trusses in pairs, over which are dentils. The upper member of the cornice is a Greek cyma-recta, above which is a panelled parapet. The upper portion of the composition is more successful than that beneath, the effect of which, however, is in a great measure neutralised by the tame treatment of the lower portion of the structure itself. This edifice adjoins that of the Scottish Amicable Life Assurance Society, previously described, which is in abrupt contrast with its quiet and meaningless neighbour. It is to be regretted that the City architect has not more control over matters of external design, in reference to street architecture, as well as construction and convenience, when such violent and startling contrasts which now so repeatedly spring up might in some measure be modified. We gladly admit, however, that in this locality, by obtaining much more space of road and footway than formerly, one of the greatest of our city improvements has been effected.

ECONOMIC WORKING OF STEAM.

SIR—Having observed for some years, that the increase of pressure in the condenser of a steam-engine does not decrease its economy in the same ratio that obtains between pressure in condenser and pressure on piston, I arrived at the conclusion that it was possible to find the maximum pressure in condenser that would give the maximum of economy when the mean effective pressure on piston was given, the feed-water being forced into the boiler at the temperature due to pressure in condenser.

The two following statements are true when taken independent of each other:

1st. The nearer we approach to a pure vacuum in the condenser, the less will be the fuel used to drive the engine.

2nd. The hotter the feed-water enters the boiler, the less will be the fuel required to convert that water into steam.

In the first the amount of fuel used decreases with the decrease of pressure in the condenser; in the second the amount of fuel used decreases with the increase of temperature of the water in the condenser, when said water is used to feed the boiler. Hence there is a temperature and pressure in the condenser at which the greatest economical effect is produced.

In order to ascertain this, let T = total heat of steam in boiler; t = temperature of steam and water in condenser; P = mean pressure of steam acting upon the piston in pounds per square inch; p = pressure of steam in the condenser in pounds per square inch.

Then the ratio of effect will be for pressure $\frac{p}{P}$, and that for temperature $\frac{t}{T}$; the maximum of economy will be obtained when

$$\frac{p}{P} = \frac{t}{T} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

But t and p are unknown, whilst P and T are known. And in order to find t and p another equation containing them must be produced; this is furnished by Southern's formula for pressures less than the atmosphere—namely:

$$p = \cdot 04948 + \left(\frac{51\cdot 3 + t}{155\cdot 7256}\right)^{5\cdot 13} \quad \ldots\ldots\ldots\ldots (2)$$

$$\text{Also } p = \frac{tP}{T} \quad \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

by transposing Equation (1). Therefore,

$$\frac{tP}{T} = \cdot 04948 + \left(\frac{51\cdot 3 + t}{155\cdot 7256}\right)^{5\cdot 13}$$

And since the temperature in the condenser will not be much affected by the quantity ·04948, it may be neglected; then by transposition we get

$$\frac{P}{T} = \left(\frac{51\cdot 3 + t}{155\cdot 7256}\right)^{5\cdot 13} \div t.$$

Giving this last equation a logarithmic form, we have

$$\log. P - \log. T = 5\cdot 13\{\log. (51\cdot 3 + t) - \log. 155\cdot 7256\} - \log. t.$$

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From which the value of t may be found for any value of P, by any of the methods of approximation. Double Position is perhaps the simplest plan, and is the one I have adopted in order to get the values shown in the following tables.

By assuming any value for P, that of T is found by the formula given by Regnault, viz.:

$$(t - 32°) 305 + 1123·7 = T,$$

where t is the temperature Fahrenheit corresponding to the pressure P of the steam in the boiler including the atmosphere. When t is found, p may be found by Equation (3).

The following table shows the temperature and pressure in the condenser when P varies from 30 lb. to 6 lb. upon the square inch. If the pressure in the boiler be increased to 70 lb. or decreased to 20 lb., the values of t and p will not be much changed, since T varies very little from the value in the table for these pressures.

Pressure in boiler = 40 lb. above the atmosphere. ∴ T = 1202° Fah.			Most economical pressure in condenser by Isditator.
P	t	p	$15 - p$.
Lbs.	Temperature Fah.	Lbs.	
30	150·5	3·72	11·28
28	146·5	3·36	11·63
26	141·9	3·02	11·98
25	140·6	2·92	12·1
24	138·6	2·73	12·27
22	134·8	2·48	12·52
20	129·6	2·14	12·86
18	125·6	1·9	13·1
16	119·	1·64	13·36
14	113·	1·38	13·62
12	105·	1·09	13·96
10	98·7	·89	14·11
8	92·5	·73	14·27
6	84·	·57	14·43

This table shows that as the mean pressure on the piston increases, the pressure in the condenser increases also, when the economical effect is a maximum; and if we increase the mean pressure still further, we soon find that condensers with pressures equal to and above the atmosphere may be used with advantage, as shown by the next table.

Pressure in boiler = 55 lb., including the atmosphere. ∴ T = 1203° Fah.			Pressure in boiler = 60 lb., including the atmosphere ∴ T = 1211° Fah.		
P	t	p	P	t	p
40	166	5·52	60	189	9·36
50	179	7·44	70	199	11·5
			80	208	13·74
			84·5	212	14·8

The above table shows that it is not essential that an air-pump and condenser of the present construction is required in order to obtain the most economical result.

If condensation near the atmospheric pressure be adopted, the temperature of the feed-water may be 212° Fah., which will dispense with the air-pump altogether, at the same time saving a great amount of unnecessary power, and consequently a great amount of fuel. And since the steam used will be of a higher pressure, the diameter of the cylinder may be much reduced, and considerable economy will be the result.

Steam of 37 lb., including atmosphere, is 6 per cent. cheaper than steam of atmospheric pressure.

Steam of 42 lb. is 7 per cent. cheaper.

" 48 lb. 8 " "
" 55 lb. 9 " "
" 63 lb. 10 " "
" 70 lb. 11 " "
" 79 lb. 12 " "
" 87 lb. 13 " "
" 100 lb. 14 " "
" 110 lb. 15 " "
" 120 lb. 16 " "

By dispensing with the air-pump, and using high steam, independent of expansion a saving of about 25 per cent. may be expected. Where new steam engines are to be erected, a very great saving in the first cost will be obtained, and a great amount of space saved.

THOMAS BARWISE, C.E.

Corn Market Buildings, Bury, Lancashire, July 3, 1858.

TRINITY CHURCH, COVENTRY.

On the 28th of June, this church, which had been closed for nearly a year and a half, was re-opened for Divine service. In the interior, extensive changes were effected in the condition and appearance of the building, which now presents one of the most complete and elaborate restorations in the kingdom. The original fabric was erected at various dates, and still retains a very beautiful early English north porch, which is groined, and has a fine moulded and shafted doorway, communicating directly into the aisle, and also a double doorway, trefoil-headed, under a comprising arch, which opens from the east side of the porch into an extra north aisle. This beautiful feature was, till lately, wholly blocked up with plastering. Generally speaking, the church is of the later styles of architecture, ranging from Decorated to perhaps almost the extreme limit of what may be called the age of Gothic art. Of these details the roofs are by far the most ornamental and interesting, unless we except the fine effect of the four piers which support the central tower and the arches, with their curious interlacing mouldings, which are in connection with them.

The work of restoration involved the rebuilding of one of the secondary piers to the tower, which had been cut away and, otherwise most recklessly treated, and had overhung its perpendicular to a serious degree. A strong system of shoring was therefore constructed to do its office of temporarily sustaining the weight and resisting the thrust of the enormous steeple, which measures in the clear width 20 feet square, and stands on four lofty piers but little more than 5 feet square each on the superficial plan.

Some very debased arches, and several ugly windows, including the east and the south transept, have been replaced by others more elegant and suitable, and new painted glass has been introduced in both of these by Messrs. Heaton and Butler, of London. The fine lantern of the tower has been opened, and once more displays its richly panelled walls. The springers of groining were found built into the walls, and this now being completed and decorated adds vastly to the magnificent effect of the interior, and does not appear to interfere with sound. Above this groining is another stage before the spire commences; the bells are not now hung there, but temporarily in a wooden belfry or campanile in the adjoining churchyard.

The church has undergone a thorough refitting, the old cumbrous galleries being wholly swept away, with the usual appurtenances and pewing. Open seats of oak are everywhere substituted, those of the nave have panelled and carved ends, with elbows and poppy-head finials; and those of the chancel are still more richly moulded and elaborated. Two ranges of stalls are provided on the north and south sides of the chancel, after the pattern of some fragments of the old ones. The sedilia and piscina have been restored, and preparation made on the blank surface of the chancel wall for a reredos, and for decoration on Parian cement. The floor is laid with Minton's encaustic tiles. The fine old stone pulpit, built against one of the tower piers (which is given in the "Glossary"), now stands forth in fresh beauty, and so does the handsome brass eagle lectern immediately below. A prayer desk is now added, which stands against the pier facing the pulpit. The font is a well known Perpendicular example, and is retained on its series of time-worn steps, rendering it a conspicuous object, especially now that it has been re-illuminated, and cramped with a tapering cover of metal work, in which natural foliage and flowers are truthfully entwined. The whole of the internal walling has been cleared of its paint and whitewashed—a tedious process—and again reveals its natural and picturesque variety of colour. The stonework of the interior is mostly of a light greyish hue, and from the quarries of Attleborough, near Nuneaton. This, however, is in some portions exchanged for the redder sandstone of the neighbourhood. For external dressings and ashlar, the stone used is from Guiting, near Winchcombe. This stone had already been employed in the partial repairs done some fifteen years ago, and is of durable quality. The new pier referred to is of picked red Mansfield. All the roofs are moulded and panelled, the original gilding and painting was in many cases discernible, and the whole of this has been carefully renewed, including some fresco subjects on the several trusses. The panels are painted in Chinese blue, and each is studded with metal stars, gilt.

The works have been carried out, as far as possible under successive contracts; the masonry being done by Messrs. Platt and Padbury, also by Mr. Pratt, of Coventry; the woodwork entirely by Riddle, of Peterborough, the wood-carving by Farmer, stone ditto by Jones; the gas standards, metal work generally, and the ceiling and other decorations by Skidmore, of Coventry.

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SMOKE FLUES FOR THE WARMING OF CHURCHES.

It occasionally happens that the destruction of churches is occasioned by the overheating of the flues, the buildings being warmed by the common hot-air or smoke-flues, carried from a furnace below the floor at one end of the church, to a chimney formed in the wall at the other end. Considering the very great non-conducting properties of brick, it seems surprising that, if proper care be taken, such an accident should ever happen; for it would appear to be only necessary to keep the flues at a proper distance from all woodwork, and no danger would arise. Now, there are two portions, at least, in every church in which a fire may originate, viz., the seating and the roof; but if heat, traversing from the flue under a passage or from a chimney passing up a wall by the roof, should set fire to either portion of the woodwork, it would seem to arise from carelessness in the construction of the flues or chimney, in not interposing a sufficient quantity of non-conducting material.

The construction of the flues and chimney should therefore be carefully attended to, and also the position and construction of the flues under the passages, taking care that they do not pass immediately under pews or wooden flooring; and a no less careful attention should be paid to the chimney, so as to secure from fire any woodwork in the roof which may be near it. As before stated, a sufficient thickness of brickwork is all that is needed.

But defects in smoke-flues have recently, in two instances, led to unpleasant results of a different kind. A clergyman reported to the Bishop of Lichfield that, in consequence of the joints of the flues not being sufficiently secure, mephitic vapours were emitted into his church in such quantities as seriously to affect members of the congregation; and the same thing has taken place in another new church, producing more alarming effects. These defects in the flues have no doubt arisen from the shrinking of the materials of which they are composed, causing the joints to open; and this accident is not easily guarded against; for it is a known property of articles made of a luminous earth to shrink every time they are submitted to a heat raised beyond that which they have previously borne.

The plan of warming churches by the means of smoke-flues, although, perhaps, cheaper in the first cost, and easier in the working than other plans, seems attended with a double danger, rendering it desirable to find other methods of accomplishing the object. Much of this danger doubtless arises from the want of a little judgment in the management of the furnace, which is too frequently left to some one whose only notion of dealing with it is to produce heat enough, not knowing that an extra degree of it applied to the flues causes them to open at the joints as just stated. The accumulation of soot in the flues is also a source of danger; for, when inflamed, the brickwork soon becomes red-hot. It is, therefore, desirable that facilities for cleaning chimneys and flues should be afforded by the introduction of soot-doors. It may be added to this, that the frequent cleansing of the flues and chimney is very requisite.

SHIRLEY, SURREY.

A new church, dedicated to St. John the Evangelist, is just completed at Shirley, near Croydon, to accommodate about 400 worshippers. The cost of the fabric (for the font, the bells, the communion service, the altar fittings, and the furniture of the chancel, were presented by different donors) has been nearly 5000*l.*; and, considering the beauty of the structure, it has been well laid out. The design harmonises charmingly with the character of the scenery, and so do the materials in which it is built, viz., walling of rapped flint, with Kentish rag-bands occasionally introduced, dressings of Speldhurst stone, and oak in the shingled spire and south porch. The roofs are covered with small red tiles. The interior walls are ashlared, partly in firestone and partly in Speldhurst, and the arches of the nave piers are in rims alternately of the lighter and darker stone. This treatment is novel, but succeeds very well. The bell-tower is at the west end, partially supported from the church by a bold triple arch in stone, extending across the whole width; the columns immediately under the angles of the turret are circular, and have handsome capitals and base mouldings. The pulpit is of oak on a stone base, and is exquisitely carved; connected with this is a low stone screen, separating the chancel from the nave. The seats are all open. The effect of the interior is much enhanced by the beautiful font which has been constructed, from the architect's design, by the Lizard Serpentine Company, in red and grey Cornish marble. Round its top is engraved a suitable inscription. The east window is filled with stained glass, as a memorial to the late Lord and Lady Eldon, and it has been ably executed by Mr. Oliphant. It is composed of five lights, the central one illustrating the ascension, the two left the crucifixion and the agony in the garden, and the two right the resurrection and the entombment. The roofs are polygonal, open to the rafters, and stained. The contractor for the work was Mr. Harris of Croydon, and the architect Mr. Scott of London.

NEW SURREY GARDENS.

On Tuesday, July 15th, the large new music hall and grounds of the Royal Surrey Gardens were formally opened to the public. The building is designed by Mr. Horace Jones, architect, of Furnival's-inn, and is rectangular in plan, with semi-octangular ends and octagonal towers at the angles, on which are constructed geometric winding staircases communicating with the various galleries both in the interior and exterior of the structure. The steps and landings of these staircases (which are circular in plan) are composed of Yorkshire stone, and they have a general diameter of 21 feet in the clear; the well-hole is 9 feet diameter, giving a projection of 6 feet to the steps from the wall on each side. The general external dimensions, including the refreshment-room, are 173 feet long and 99 feet wide; the interior of the hall itself is 153 ft. 6 in. by 68 ft. 6 in., with a height of 77 feet to the underside of the three octagonal lights in the roof, which is circular, and terminated at each end with semi-domes, apse fashion, under one of which the orchestra is constructed. The roof is formed of curved ribs, in two thicknesses of Memel boards, 1¼ inch thick, between which a rib of wrought iron is inserted, ⅝-inch in thickness, an ingenious contrivance at once strong and simple. These ribs are connected by purlins in the usual manner. There are three galleries for the accommodation of the audience, which are continued all round the walls internally, except at the eastern end, reserved for the orchestra. The two lower galleries project 16 ft. 6 in. from the wall, and the upper one 13 feet, and are supported by iron columns, the foundations of which are connected together by inverted arches of brick, 18 inches in thickness, bedded in cement. The fronts of the lower galleries have ornamented iron-work, with the representation of musical instruments on them, gilded, the other portions being white. The two external galleries, which overlook the lake and command an excellent view of the painting of the city of Constantinople by Mr. Danson and his son, are in width, respectively, 8 ft. 6 in. and 5 ft. 9 in.

The interior of the edifice has not yet received the amount of decoration which is ultimately intended, but notwithstanding, from its great size and peculiar arrangements, has a very imposing effect. The acoustic properties of the Hall have been pronounced to be of a very first-rate quality. The ample refreshment-room, communicating with the music-hall, is nearly 100 feet in length and 40 feet in width, fitted up with great simplicity and taste, having counters in the centre, covered with marble, supported on panelled wooden frame-work. The walls and ceiling are covered with stripes of pink calico on a white ground. The design of the building partakes principally of Italian features (and not Gothic, as has been erroneously stated by one of the daily papers), the terminations of the towers, however, having something of an Oriental character about them, and do not quite harmonise with the main body of the edifice.

Music-halls now becoming a sort of fashionable building in the metropolis, we have been somewhat minute in our description of this one in particular, which, with some faults, presents as a whole a very favourable sample of the class, and contains much to commend in a constructive point of view; we fear, however, that exception must be taken to the steps of the stairs, particularly those parts nearest to the well-hole, which are evidently too narrow in the tread.

The grounds have been very tastefully laid out by Mr. Forrest and Mr. Barton, of Lower Norwood, with the artistic aid of Mr. Danson, who has produced some very extraordinary grottos and caverns, which seem to beat what nature has done at Matlock and Castleton. In the grounds, also, a Turkish kiosk is constructed close to the lake, in which smoking may be enjoyed in the true Oriental style; the approach to this smoking-divan, is, however, out of keeping with Turkish architecture, and should be altered for the sake of harmony. Very great credit is due to the architect—to Mr. Tyler—the contractors, Messrs. Scott and Cornwall, and all others concerned, for their exertions in having brought the whole to completion in the short space of four months.

COMBINATION OF MASTERS.

The builders and contractors of Cardiff have lately established a society among themselves, and are desirous of pointing out to the contractors of other towns the advantages of establishing similar institutions in their respective localities, and of a general union of the societies thus formed. It appears that the originators have been subject to unreasonable demands from the operative masons, and resisted for some weeks a strike consequent thereon, which this co-operation among themselves has enabled them to maintain with great success. By the formation of a similar association, it will be remembered that the engineering firms were enabled, a few years ago, to thwart the "Society of Amalgamated Engineers," by which they were at that time completely oppressed; and it is urged by the founders of the new society that it is "well worth the consideration of contractors, whether they should not for the future put themselves in a position to stop the unreasonable demands from which we have suffered so much."

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THE NEW NATIONAL GALLERY.

One of the most important topics of the past month in reference to architectural science has been the discussion in Parliament of the removal of the National Gallery to Kensington Gore, by the Commissioners of the 1851 Exhibition, with Prince Albert at their head. It will be remembered by our readers, that previously a company was in course of formation to get possession of the present National Gallery, in order to convert it into a monster hotel, on the plan of the imperial hotel in the *Rue de Rivoli* at Paris, and that there were even found "Goths in Parliament" to sanction this monstrous proposition. Every one who has any regard for the fine arts, who is at all conversant with that of architecture in particular, or who has any regard for the few national buildings which our metropolis possesses in comparison with its enormous size, wealth and importance, were filled with a just and laudable indignation at the movement then going on, which comprehended no less than the demolition of Wilkins' building in Trafalgar-square. Amongst numerous others, we have no very enthusiastic admiration of the architecture of the National Gallery, as a great work of art, but if any impartial judge in such matters will take the trouble to glance his eye from one end of the façade to the other, and mark well the line it forms against the sky, it is believed it will be found upon the whole that this much maligned structure is not so highly objectionable in its general features as the majority of people imagine, and most of its defects must be laid to the injudicious parsimony of our ministers who were in office at the time of its erection, and not to its architect, whose memory has been assailed with such a large amount of unmerited opprobrium and abuse. We readily admit that, by the substitution of the old Carlton House columns, the portico was rendered a mixture of Greek and Roman architecture, which should not have been tolerated by Wilkins; but, nevertheless, with a moderate outlay compared with the enormous sums that have been wasted by our government in experimental architecture, it is contended that if this structure be retained, it is quite possible, should it be abandoned by the Royal Academy, that it might be converted into one of the finest picture galleries in Europe, and its exterior made to rival any public building which we have in London.

That the Royal Academy should be entirely removed from the present National Gallery building, no one will be disposed to deny, except the band of Academicians who now hold undisputed sway at that establishment; and as to the assertion that it comprehends a school of painting, sculpture, architecture, and engraving, it is by no means anything of the kind. From the period of its founding by Reynolds and others, to the present time, it has been nothing more nor less than a very ordinary drawing school, and an exhibition for the sale of pictures. Sir Joshua Reynolds said that two of a trade could never agree, in reference to his brethren of the brush and palette. This the painters of the Academy have fully illustrated in their perpetual bickerings and jealousies, and their excluding from "the line" all meritorious works by painters not in their own clique. It is also commonly known that the manner in which both our sculptors and architects have been treated, has been of the most unjust description. The former have had their works, however admirable they may have been, whether busts of the queen or groups from classic history, packed away into a dreary cellar, year after year, and the architects have had their designs and drawings hung high and low, without system or arrangement, and in the most confused manner. Under these circumstances, when the proper time arrives, and the site for the new National Gallery determined upon, we shall earnestly propose the entire separation, not only of the National Gallery from the Royal Academy, but also the separation of the painters from the sculptors and architects. This *must* be done, if the *true* fine arts are to be expected to advance in England. *Painting*, under Ruskinism and the pre-Raphaelites, is becoming next to despicable; English *sculpture* is drooping, owing to the unjust and ungenerous patronage of foreigners through the influence in high quarters; and the architects are fast hastening to the desirable epoch, when they will throw aside the trammels of the Royal Academy, and the dictation of its feeble dogmatic teachers, and will have an establishment of their own, the nucleus of which is already formed at the architectural exhibitions in Suffolk-street. It must be a source of the most heartfelt congratulation to all true lovers of Art, that the Prince Consort's scheme of removing the National Gallery to the damps and fogs of Kensington Gore, was abandoned in Parliament on the motion of Lord Elcho, in which fortunately the conductors of the "Times" participated. Never was a more injudicious or more unjust proposition made, or attempted to be carried; in fact, the purchase of the Kensington Gore estate has been an entire mistake—a grave blunder from beginning to end; and even now, notwithstanding the 25,000*l.* which has already been wasted in the erection of what has not inaptly been termed an iron "Hospital for decayed Railway Carriages," the best course to be adopted is at once to check all further waste of public money, and take the wholesome advice given by one of the members of the House of Commons, which is, to sell the estate, which might be done with advantage to some speculative builder, and on which he might erect a second Belgravia. As to the idea of transporting the contents of Marlborough-house and the pictures in the National Gallery to Kensington Gore, it is unreasonable, as leading to a most injudicious waste of the public money,—and would also be a great injustice on the claims of the people, who surely ought to be allowed the pleasure of viewing their own property in the most convenient, cheap, and agreeable manner, without being compelled to trudge on foot to the outskirts of the metropolis to do so. Do not, however, let the opponents of the Prince's scheme rest on their oars; for depend upon it their triumph is only half complete, and the secret influences of the court will again be at work to gain their point; and as our witty contemporary, "Punch," satirically advises the court party,

> "Let the whip be with greater severity plied,
> And a little more dexterous influence tried,
> And the public may yet have to travel footsore,
> For a sight of its pictures, to Kensington Gore."

Again, in an educational point of view, was there ever anything so unwise as the proposal to remove the so-called School of Practical Art from Marlborough-house to Kensington Gore? The attempt to teach the art of design both at Somerset-house and at Marlborough-house has proved as nearly as possible an entire failure; what will it be when the central school is removed into the outskirts of London?

Amongst the various sites that have been proposed for the new National Gallery, in and out of Parliament, the following are enumerated:—1st. Kensington Gore; 2nd. Kensington Palace; 3rd. St. James's Palace and a portion of Pall Mall; 4th. The margin of the Thames near Whitehall; and 5th. The Botanical Gardens in the Regent's Park. No one will, we think, deny that the whole of these proposed sites are more or less objectionable. If we are to go to the suburbs for a site, that site should be Hampstead Heath; most assuredly neither the Regent's-park nor Kensington Gore. If the Heath is chosen, it presents many advantages, and gets rid of the chimerical objection in reference to vitiated air injuring the pictures. We contend, however, with the writer in the "Land and Building News," that the present site for the Gallery should be maintained, and as he justly observes in reference to the assertions that its future extension would be impossible, that "it is simply absurd to talk of such a thing in connection with the National Gallery of Great Britain," and adds further, that "to Englishmen who have not seen what has recently been done in Paris, it may seem astounding to talk of asking for frontage from the Haymarket to St. Martin's-lane, but nothing less would be sufficient for the façade of such a National Gallery as we might possess twenty years hence, if we had a proper building to receive gifts and legacies." The writer continues to draw a glowing picture of what might be accomplished on this "finest site in Europe," by which a scene of architectural splendour and magnificence would be obtained in connection with the Houses of Parliament, Westminster Abbey, and the proposed new approach from Northumberland-house down Parliament-street.

Unless, however, our ministers in power assume a more independent spirit, and divest themselves of the pernicious influences of court control, this will never be accomplished. Could this scheme, however, be realised, there is no doubt that we might possess a structure rivalling if not excelling the Louvre at Paris, which still remains, as Voltaire said, the grandest national monument in Europe.

The erection of a monument, at Chesterfield, to the memory of George Stephenson has been proposed. He resided at Chesterfield during the latter part of his life, and his remains are deposited there.

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REGISTER OF NEW PATENTS.

(With Engravings, Plate XXIV.)

PROPELLING VESSELS.

JAMES LOWE, East Greenwich, *Patentee*, June 16, 1855.

This "improved apparatus to be employed in place of paddle-wheels or ordinary stern propellers for propelling vessels" relates to improvements upon that description of propeller commonly known as screw propellers, and which are usually placed at or near the stern of the vessel. These propellers usually consist of two or more wide vanes or blades, mounted on or attached to a boss, which is keyed on to the propeller shaft. It is discovered, however, that a considerable portion of the surface of these propellers, as usually constructed, does not act properly and effectively on the water, and consequently there is considerable slip or waste of power.

The first feature of novelty in the apparatus which constitutes the present invention, consists in dividing the blade or vane of screw propellers into two or more parts, and placing them in pairs or sets in or near a line which passes diagonally across the boss. By thus dividing the propeller into parts, the second half of the propeller is made to act more effectually than heretofore, and the choking action incidental to ordinary stern propellers is obviated, as a portion of the water that has been acted on by the first section of the propeller is allowed to escape between the first and second sections, and the latter will then be able to act with greater effect on the water.

The next improvement relates to the form of the propeller, or rather of the blade or vane. When pairs of blades (that is, sets of two blades) are used, the first one of the pair is to be made slightly convex, or bowed, with the front edges chamfered off, so that it may enter the water more quickly than if left square. The second blade is, on the contrary, made slightly concave in the direction of its length, so that when the water slips from the first blade of a pair on to the second, the latter will act more effectually than if it were straight or flat, or made convex like its fellow. The patentee proposes sometimes to employ three or more in a set, and two, three, or four sets may be adapted in a proper manner to the same boss, which is made of an elliptical shape. In order to construct the blades of this propeller so as to give it the desired configuration, the following process is adopted. The patentee takes a piece of iron, wood, or other material (see figures 1, 2, 3, and 4), of a size (say, for example, 4 inches thick and 6 feet long), depending upon the diameter of propeller required to be made. He begins by first drawing a line ×, ×, all around the middle of the edge of the intended blade, as indicated in the edge views, figs. 2, 3, and 4. This line forms a guide or gauge of distance up to which the several cuttings hereafter mentioned are to be carried. Having thus marked out this line upon the blade, he takes a cutting in the direction of the line 1 . . . 1, fig. 2, and chamfers off the piece marked *z*, *z*, up to the centre line ×, ×, from edge to edge of the blade, and in the direction from left to right, gradually cutting off a portion of the thickness of the edge of the blade, figs. 1 and 4. He then takes a cutting in the direction of the line 2 . . . 2, fig 3 (which makes a bevil in the opposite direction to the last), that is, from right to left, and chamfers off the piece *y*, *y*, on the same side of the blade and up to the centre line ×, ×. After having thus chamfered away the face of one side of the blade, he turns it over and proceeds in like manner upon its other side in the direction of the lines 3 . . . 3, and 4 . . . 4, of figs. 2 and 3, the chamfering being as before in opposite directions, thus making the two faces exactly alike, and with a kind of twist on the face. When this has been done, the back angle of each side or edge of the blade will coincide with the line 5 . . . 5; he then slightly rounds off the front edges of the blade, so that it may enter the water more easily. It will now be seen, on applying a "straight-edge" to the face of the blade on the line 6 . . . 6 of fig. 1, that its surface is concave; and, on the contrary, when the "straight-edge" is applied on the line 7 . . . 7 of the same figure, its surface in that direction will be convex, forming a curve inwards between the extremes of the line 6 . . . 6, and a curve outwards between the extremes of the line 7 . . . 7. By constructing a blade in this manner the angle on the face of the blade is made to vary gradually between the outer edges and periphery. Fig. 5 represents, in perspective, this mode of constructing the blades.

Fig. 6 is a plan of a propeller having two pairs of blades; fig. 7 is a side elevation, showing a propeller of this construction applied to the stern of a boat; and fig. 8 is an end view of the same. In proceeding to fix these propellers upon their boss, the patentee first draws a line *a*, *b*, diagonally upon the surface of the boss *c* at an angle of about 33° with the axis of the propeller shaft *d*. Upon this line *a*, *b*, at a suitable distance on either side of a centre cross line *e*, *f*, he marks upon the boss the positions where the respective blades *g*, *h*, are to be placed, the centre line of the plane of the base of each blade coinciding with the diagonal line *a*, *b*, as shown at fig. 6. Having thus defined the positions of the blades *g* and *h*, he turns the boss half a revolution, and proceeds in like manner for determining the position of the other pair of blades *i* and *k*. When three pairs of blades are used, as shown at fig. 9, three diagonal lines are drawn upon the boss, and the positions of the blades are determined in a manner analogous to that before described.

In figs. 10 and 11, a propeller is shown wherein the above arrangement of the blades and also the formation of the same are somewhat modified. In this arrangement a curved twisted blade is used as shown; and instead of fixing them on the diagonal line *a*, *b*, as before described, they are placed out of the line, one blade being on one side and its fellow blade on the other side of such line, as shown at fig. 10; the side of each base or root of each pair of blades (as shown in the last-mentioned fig. 10), instead of the centre of the plane of the base, as above mentioned with reference to figs. 6, 7, 8, and 9, being made to coincide with the said diagonal line. By the peculiar configuration given to these blades by reason of their twisted form, an opening between the blades constituting each pair is formed, through which any substance likely to obstruct the action of the propeller when in operation can readily pass; each side of the edges of the blades is chamfered or bevilled, so that should the vessel be engaged in deadly combat with the enemy, any broken masts, sailcloths, &c. coming within range of the propeller may be chopped, cut, or divided by the same, by reason of its sharp or bevilled edges, and thus be prevented from obstructing its action.

The patentee observes that although he has mentioned 33° as the angle which he prefers to mount the propellers or blade on the boss in reference to the axis of the shaft, yet he does not confine himself to that particular angle, as it may doubtless be varied and produce a satisfactory effect.

Claims.—1. Dividing the blade or vane of screw propellers into two or more parts, and placing them in pairs or sets in or near a diagonal line drawn across the boss, as above described.

2. The method above described, with reference to figs. 1 to 5, whereby the proper formation is given to the propeller blade.

3. The employment of an elliptical propeller boss in place of the ordinary bosses now used.

4. Constructing and mounting the blades of the propeller in the manner shown in figs. 10 and 11, or any mere modification thereof for effecting the desired purpose.

RAILWAY BUFFER SPRINGS.

GEORGE RICHARDSON, *Patentee*, November 28, 1855.

THIS invention relates to an improved construction and arrangement of springs, composed of caoutchouc or gutta-percha, either separately or in combination with each other, or with other suitable elastic gums or materials, for railway carriages and wagons, whereby a saving of material will be effected, and the size of the containing chambers or cases considerably reduced, and the amount of elasticity increased.

The improvements consist in the employment of one or more hollow cylinders of vulcanised india-rubber or gutta-percha, either separately or in combination with each other, or with other suitably elastic gums or materials, such cylinder or cylinders having a concave circumference, that is to say, the diameters of the cylinders at each extremity is greater than at the middle, by which means the outward bulging of the cylinders when under compression is obviated, and the boxes or cases enclosing them may therefore be made of smaller diameter for the same strength of spring than hitherto, as less space will be filled by the cylinders when under compression than in the ordinary existing india-rubber buffers.

The cylinders, when more than one are used, have metal discs interposed between them, and the whole are contained in suitable sliding boxes or cases, somewhat similar to those in ordinary use for this class of springs. It is proposed to adopt the peculiar

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Heilmann's Grates for Steam Boilers.

Fig. 1

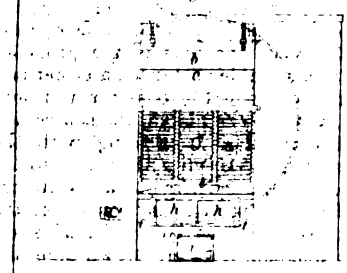


Fig. 2

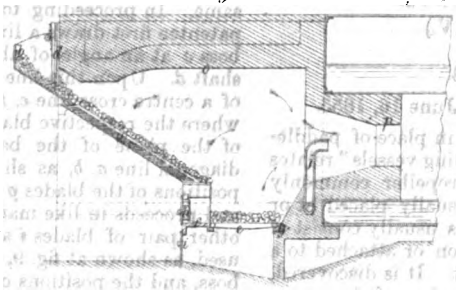
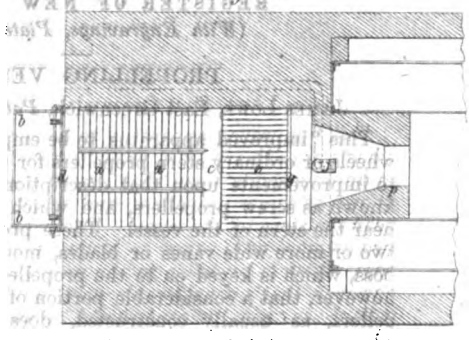
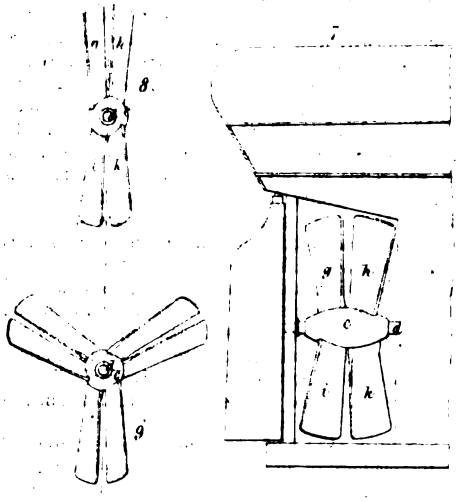


Fig. 3

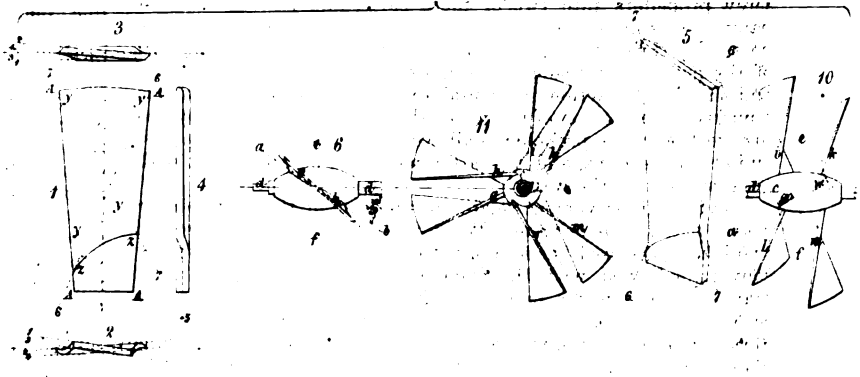


Figures



Lowe's Screw Propeller.

Figures



Hicks' Guage Valve.

Fig. 1.

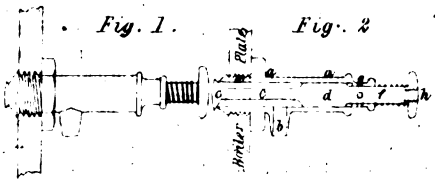


Fig. 2

Richardson's Draw & Buffer Springs.

Fig. 2.

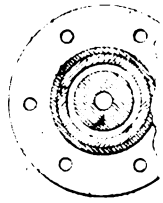
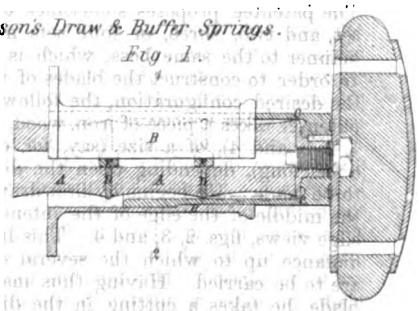


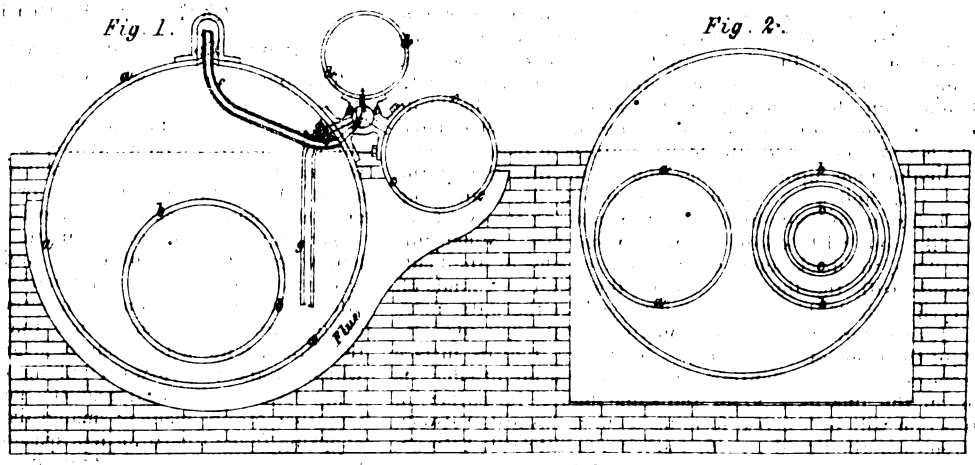
Fig. 1



Allman's Steam Generator.

Fig. 1.

Fig. 2.



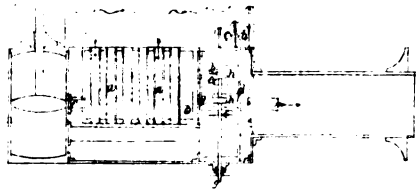


Fig. 3.

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concavo-cylindro form of elastic cylinders, herein-before described, in constructing the bearing springs for railway carriages and wagons, as well as the buffer and draw springs for the same.

Fig. 1 represents a longitudinal section and partial elevation of a buffer constructed according to this invention; and fig. 2 is a transverse section of the same, taken along the line 1, 2, in fig. 1, with a portion of the bolting flange broken away.

A, A, are hollow cylinders of vulcanised india-rubber, in combination or not with other suitable elastic gums, or gutta-percha. These cylinders, in place of having their outer sides parallel, as is ordinarily the case in buffers or springs of this class, have their sides slightly concave, that is to say, the diameter of the cylinders at each extremity is greater than at the middle, by which means the outward bulging of the cylinders when under compression, as shown by the dotted lines in fig. 1, is obviated, and the boxes or cases B and C, enclosing them, may, therefore, be made of smaller diameter for the same strength of spring than hitherto, as less space will be filled by the cylinders when under compression than in the ordinary existing india-rubber buffers, which are made with parallel sides, as shown by the thick lines. These cylinders, when more than one are used, have metal discs D, D, interposed between them, and the whole are contained in the sliding boxes or cases B, C, similar to those in ordinary use for this class of springs, but the central spindle is dispensed with; the metal discs D having shoulders or projections E, E, formed on each side to fit into the hollow or interior of the respective rings or cylinders. This peculiar concavo-cylindro form of elastic cylinder is obviously applicable in constructing the bearing springs of carriages and wagons, as well as the draw springs for the same.

Claim.—The application and use of springs composed of india-rubber or other elastic gums in the form of cylinders, such cylinders having a greater diameter at the two ends than in the middle, in the manner and for the purposes hereinbefore described.

GUAGE VALVES FOR STEAM BOILERS.

JOHN HICKS, *Patentee*, November 5, 1856.

Fig. 1 is an elevation of a guage valve constructed according to the patentee's improved method; fig. 2 is a longitudinal section of the same. *a*, *a*, is a cylindrically-shaped tube, of brass or gun metal, or of any other suitable material, having at the under part thereof a cylindrical and hollow nozzle or discharging passage *b*, which may be either cast so as to form part of the tube *a*, *a*, or may be fixed upon or to the same in any suitable manner; *c*, *c*, represents a piston or valve spindle, composed of brass or gun metal, steel, wrought or cast iron, or of any other suitable material, and which is constructed of different dimensions in different parts of its length; the largest diameter marked *d* accurately coinciding with the greatest bore of the tube *a*, *a*, and being turned and ground so as to work therein in a perfectly steam and water-tight manner. The portion of the piston or valve spindle marked *f* is also turned and ground, so as to fit the collar *g* at the end of the tube *a*, *a*, and to work therein, so as to be perfectly steam and water-tight without requiring any packing or stuffing for that purpose. The external end of the piston or valve spindle is furnished with a terminal knob or plate *h*, and the other end thereof is constructed so as to form a conical or button valve, which may be either a portion of the same piece of metal as the piston or valve spindle, or may be soldered, or screwed, or otherwise properly fastened thereto, the said conical or button valve being ground and accurately fitted to the valve seat, which is constructed at the corresponding end of the tube *a*, *a*. Upon that portion of the piston or valve spindle marked *f*, between the collar of the tube *a*, *a*, and the terminal knob of the piston, is placed a spring, composed of steel, brass, or caoutchouc, or any other suitable elastic substance, the object of such spring being to retain the valve upon the seat herein-after mentioned.

Having described the construction of the improved guage valve, the manner in which it is applied and put in operation is thus explained:—That end of the tube *a*, *a*, in which the valve is fitted, and which is marked a^1 in fig. 2, is screwed into the boiler plate, so as to allow the steam or water, as the case may be, to come into contact with the valve, thus pressing the latter against its seat and keeping it perfectly steam and water-tight. When it is desired to test the presence of steam or water in the boiler, the plug or piston is to be pressed into the tube *a*, *a*, by means of the terminal knob *h*, thus causing the valve to open sufficiently to allow the steam or water, as the case may be, to rush in and escape through the nozzle or discharge passage *b*; upon the pressure being removed, the plug or piston will resume its normal or original position, by reason of the pressure exerted upon the valve by the fluid contained in the boiler, and by the tension of the before-mentioned spring.

It is the patentee's intention to apply and use this invention principally as a guage valve for boilers of steam engines; but it is also applicable, as is manifest, to many other purposes, and amongst others, as a tap for drawing off fluids, and as a means of testing the position or quantity of any fluid contained in any kind of vessel, and also for regulating or permitting the admission or emission of steam or other fluids.

It will be observed that this invention combines several advantages. The cost of the manufacture of guage valves according to the patentee's method is, in the first instance, comparatively small, while from the simplicity of their construction and operation they are not so liable to fracture, leakage, or disarrangement as ordinary guage valves or taps.

Claim.—The general arrangement and combination of the several parts, which together combined form the guage valve or tap.

STEAM BOILERS.

FENNELL ALLMAN, *Patentee*, November 3, 1855.

THIS invention is for the production or generation of steam in two or more vessels, which vessels may be defined as follows:—By boiler is meant a vessel in which both steam and water are used; by chamber, a vessel which contains only steam, and to which heat is not necessarily applied; by calorifier, a vessel which contains steam, and to which heat is applied. In the following arrangement three vessels are used, the boiler, chamber, and calorifier. The steam is generated from the water in the boiler, and from thence is emitted by a valve, cock, or other suitable contrivance into the chamber, which it fills; but the chamber has another valve or cock, which is opened into the third vessel or calorifier after the valve, cock, or other suitable contrivance leading from the boiler to the receiver or chamber is shut, so that only the amount of steam contained in such chamber can at one time or one opening of the valves be admitted from the boiler through the intermediate chamber into the calorifier. The action of such an arrangement is as follows:—The steam being raised in the boiler as in the ordinary way is passed into the chamber (the use of which chamber is to measure the steam, or allow only a certain amount to pass from the boiler, and to prevent the steam from the calorifier from returning back to the boiler, except what may pass into the boiler on the closing of the valve or cock at the end of the chamber admitting the steam into the calorifier, and on opening the valve or cock admitting the steam from the boiler to the chamber at each opening of the valve). The chamber being full, and the valve communicating with the boiler then shut, the steam from the chamber is allowed by a valve, cock, or other suitable contrivance, to flow into the calorifier, in which it receives an extra dose or amount of heat or caloric; from the calorifier it is emitted to the engine or apparatus which it is intended to move, or for other required purposes.

By this arrangement it will be seen that the calorifier is never in direct communication with the boiler, and that the chamber is alternately in communication with the boiler and calorifier. This intermediate chamber prevents the dry steam in the calorifier passing back into the boiler, or more than a certain definite quantity of steam entering the calorifier from the boiler. With respect to the form and construction of such vessels, the boiler may be of the ordinary construction; the chamber, any conveniently shaped vessel, made sufficiently strong to resist steam of very high pressures; and the calorifier of similar strength; and having a large amount of fire surface, so as to heat the steam rapidly. The valves or cocks herein described may be worked by hand gear, or by the motion of the machinery the steam is applied to. One or more calorifiers may be applied if steam is required of various pressures or temperature. No claim is made to any particular form, shape, or dimensions for such vessels, as such must be determined by the amount and pressure and temperature of steam required, and as the construction of such suitable vessels is well understood.

Such being the nature of the invention, by reference to figures in Plate, an arrangement of apparatus suitable for carrying it into practice will be fully understood.

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Figs. 1 and 2 exhibit transverse sections of boilers fitted with the improved apparatus, and fig. 3, a vertical and longitudinal section of smoke box and cylinder of locomotive.

In fig. 1, *a*, *a*, denotes the shell of boiler; *b*, *b*, the internal flue; *c*, *c*, *c*, *c*, the calorifier; *d*, *d*, *d*, *d*, the chamber; *e*, *e*, *e*, *e*, a four-way cock, by which the communication is obtained between the respective vessels. In the position in which the cock is shown in drawing, the communication between the steam space of boiler and the chamber is open, so that the steam from the boiler has free access to the chamber through the pipe *f*, *f*. Now, by giving the cock a right-hand movement it connects the chamber with the condensing pipe *g*, *g*, and, by continuing the movement, it opens the passage between the calorifier *c*, *c*, *c*, *c*, and the chamber *d*, *d*, *d*, *d*. *h* is a self-acting clack valve, opening in the direction of an arrow, and one may also be placed in the steam-pipe from the calorifier to the machinery to be moved. Now, it will be evident that the chamber being filled with steam from the boiler through the cock in its present position, that by giving the cock a right-hand movement, so as that the passage in the cock will assume the position indicated by the dotted lines, that then the communication between the chamber and the boiler will be shut, and the communication between the chamber and the calorifier open, so that the steam from the chamber passes into the calorifier, and there receives an extra dose of heat. From the calorifier the steam is emitted for use, as to produce motion in machinery, or for other purposes. Now, when the steam has so passed from the chamber into the calorifier the cock receives a left-hand motion, by which it is brought back to the position indicated, successively uniting the chamber *d*, *d*, *d*, *d*, with the pipe *g g*, through which any dry steam passes from the chamber into the water of the boiler; and, secondly, uniting the chamber *d*, *d*, with the pipe *f*, *f*, through which the chamber receives a charge of steam from the boiler, and then the above-explained movement of the cock is repeated. The motion may be given to the cock *e*, *e*, *e*, *e*, by hand or by the movement of the machinery. The capacity of the calorifier may be about one-tenth of the steam space in the boiler, and the chamber about one-eighth of the said steam space in the boiler. The calorifier is exhibited as being heated by the boiler flue, but it may also be heated by a separate fire. A safety-valve may be attached to the calorifier.

Fig. 2 exhibits a transverse section of boiler with double internal flues *a*, *a*, *b*, *b*. In one of these flues, *b*, *b*, the steam cylinder *c*, *c*, is placed, surrounded by a jacket *d*, *d*. This jacket is used as a calorifier, as in *c*, *c*, *c*, *c*, fig. 1, the chamber being placed in the steam space of the boiler, the manner of working and feeding such chamber and calorifier being the same as in fig. 1, proper pipes being used to suit the alteration in the position of the parts. By this arrangement the entire draft of flame and hot air from the furnace may be sent either wholly through the flue *a*, *a*, or *b*, *b*, or partly through each, by having dampers at the mouth or the back of the flues.

In fig. 3, *a*, *a*, *a*, *a*, denotes the calorifier, being a rectangular vessel, fitted with tubes to correspond with the boiler tubes, so as to receive and conduct the hot air and flame from the boiler tubes into the smoke box; *c* is the steam passage from the steam space of the boiler, and united to the port *b* in the chamber *d*, *d*; *b* is the tube leading to the water of the boiler; *e*, *e*, is the steam port, conducting the steam from the chamber to the calorifier, and *f*, *f*, unites the calorifier with the cylinder; *h*, *h*, indicate the valves which close the ports *b*, *c*, and *e*, *e*. By giving motion to the valve rod *g*, it will be evident that the chamber *d*, *d*, will be alternately and successively connected with the calorifier, as exhibited, and then with the passage *b*, leading to the water of the boiler, and next to the tube *c*, leading to the steam space of the boiler. The same end is obtained in this arrangement as in figs. 1 and 2, namely, that of taking a definite quantity of steam from the boiler through the intermediate vessel, cutting off the passage to the boiler, and allowing such steam to enter the calorifier to receive an extra dose of heat. The relative size, strength, or heating surface of the calorifier, will depend on the dose of heat to be given, or the extent to which the steam is to be surcharged with heat or desiccated, all which is well understood by practical men. It is preferred to maintain the temperature of the metal of the calorifier at about 400° Fah.; but this may be varied, as is well understood; the amount of heat necessary to maintain such temperature depending on the quantity of steam passing through it. The form of the apparatus in fig. 2 enables this to be regulated. Steam produced by an apparatus such as described may be used on issuing from the calorifier, either alone or in combination with other steam direct from the boiler, or not dried or desiccated, in the manner described. The mixture or combination of such dried or desiccated steam with steam not so dried or desiccated will occasion a sudden increase in the elastic force of the combined steam, available for motive power or other uses.

Claim.—The adapting apparatus for producing steam in a series of vessels as above described.

FURNACES OF STEAM BOILERS.

CÆSAR HEILMAN, *Patentee*, December 5, 1855.

This invention consists in an improved combination of the parts constituting the grate or furnace for a steam boiler, which may be applied either in front of or under the boiler, according to its construction. The improvements in grates or furnaces consist in the combination of a set of horizontal grate bars placed one below the other, the lower bars projecting beyond the upper ones to form an inclined surface, and a horizontal set of grate bars with a hopper, furnished with a sliding door to regulate the admission of the coal, and a fire-brick arch over the grates to promote the combustion of the coals.

Other improvements consist in contracting the opening of the flue or flues, for the purpose of uniting the products of combustion as they pass from the grates to the flues of the boiler, thereby increasing the consumption of the smoke.

Fig. 1 is a front elevation, fig. 2 is a sectional elevation, and fig. 3 a plan, in section, of the improved grate or furnace, and of part of a single-flued boiler to which it is applied. *a*, *a*, are horizontal grate bars, which are placed in an inclined direction and at such an angle that the coal from the hopper *b* has a tendency to drop from one grate bar to the other until it arrives at the foot plate *c*; this plate projects inwards sufficiently to allow of the requisite accumulation of coals on the grate bars *a*. The patentee prefers to place the grate bars *a*, *a*, at an angle of from 35° to 40°, as he finds from experiments that such angles are best adapted to the descent of the coals; but the angle must be determined by the quality or description of coal to be consumed. The depth of coal on the grate bars *a* is governed by means of the sliding door *d* in the hopper *b*; this door is raised or lowered by racks and pinions, or in any other convenient manner. The coal in descending the inclined grate *a* becomes partially consumed, and as the hopper is kept constantly supplied with fresh coal, the pressure from above causes the partially coked coal to fall over the foot plate *c* on to the short horizontal grate bars *e*; these bars are supported at one end by the dead plate *f*, and at the other by the rail *g*, let in the brickwork. The clinkers can be removed from the grate *e* through the doors *h*, *h*, and the ashes through the door *i*; these doors are kept closed, in order to compel the air requisite for the combustion of the coal to pass between the grate bars *a*, *a*, and through the coal upon them, but a further supply of air may be introduced through the pipe *j*, the orifice of which is closed or partially closed, when required, by the sliding door *k*, shown in fig. 1. The doors *h*, and the space above the grates *a* and *e*, are arched over with fire-brick or other material, and the orifice of the flue in the boiler is contracted with fire-brick or other material, as shown at *p*, in figs. 2 and 3. When the grate or furnace is in its regular working condition, the fire on the grate bars *e* is composed of coke in an incandescent state, and that on the inclined grate *a*, is fresh or green at the top near the hopper, the combustion gradually increasing as the coals approach the lower end, where they accumulate on the foot plate *c*, from whence they fall, as before stated, on the grate *e*. The attendant is enabled to ascertain the state of the fire on the grate *a*, by looking between the grate bars, and he is also enabled to regulate the descent of the coals by passing a suitable instrument between the bars. The clinkers from the grate *e* are cleared out occasionally through the doors *h*, *h*. The arch *o* above the grates *a* and *e*, is made sufficiently high, that the smoke rising from the green coal is obliged to descend before it enters the contracted orifice *p* of the flue, by which means the unconsumed smoke is brought into contact with the heated air and gases arising from the fire on the grate *e*, thereby effecting the consumption of the smoke, the atmospheric air admitted by the pipe *k* assisting to accomplish this object.

Claim.—The combination of a hopper, an inclined and a horizontal grate with the arch over them, and the contracted orifice of the flue.

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SIR C. BARRY'S REMUNERATION.

A parliamentary paper dated July 18th gives some particulars of the negociations between Sir Charles Barry and the Government respecting his remuneration as architect of the New Palace at Westminster. The Lords of the Treasury, in a special minute, observe that it is clear from the premises—1. That Sir Charles Barry accepted a certain proposed sum, after a distinct refusal of explanation regarding the principle on which it was proposed; 2. That he was well aware at the time that it was far short of the usual remuneration to architects; and, 3. That he well understood that it was intended as the whole remuneration which he was to receive for the superintendence, direction, and completion of the intended edifice; and that it is now, therefore, too late for him to raise questions and found claims. Their lordships accordingly concur in the recommendations of the First Commissioner of Works, and desire that Minister to govern himself thereby. These are to the effect that Sir C. Barry do receive, as a further remuneration for services connected with the warming, lighting, and ventilating arrangements, a sum of 4925*l.*, and that an allowance for measurement of 1 per cent. be for the future made only upon such accounts as require the service of a surveyor for their preparation, unless the architect be authorised by the Board of Works, under the approval of the Treasury, to make any special charge for special services so authorised. In bringing this matter to a conclusion, their lordships feel it right to observe that when they agreed to a payment to Sir C. Barry, at a rate of 1 per cent. for measuring, they had before them a report of the Board of Works, whence it appeared that if the measuring were conducted under the direction of the Board, the remuneration to professional measurers for the work would be made by "a commission varying from ½ to ¾ per cent." Their lordships therefore consider that in allowing Sir C. Barry 1 per cent. he will receive ample remuneration for any duties imposed upon him personally in connection with the measuring; and they add that, under the circumstances, they will have conceded payments to him considerably exceeding the sum to which he would have been entitled for the mere duty of measuring.

PROPOSED UNDER-SHORE TUNNELLING OF THE RIVER THAMES.

Mr. William Austin has submitted the following plan to the Metropolitan Board of Works:—

A proposed tunnelling of each bank of the river, as intended to be constructed below the mud shores, at the lowest practical level, for recipients of sewage discharges from street sewers on each side of the Thames was first introduced to notice of Metropolitan Commissioners and their engineer (the late Frank Foster, Esq.), in 1850, which was most favourably received by them; but the arrangements, although commended, were then considered premature. It is now again brought forward to the public notice, in the sincere hope "that its advantages may be apparent," and its adoption practically prove its value.

The tunnels are intended to act as main conduits for conveying all the valuable sewage to reservoirs below Barking reach and the opposite shore, where (without giving offence or annoyance to the surrounding neighbourhoods) it will be converted, by a valuable patented chemical and mechanical treatment, into a most fertilising agricultural manure, in the shape of blocks, or in powder—equal, if not superior to Peruvian guano (at much less cost), and affording a handsome return and profit to spirited moneyed capitalists, instead of being wasted on the shores of the Thames, spreading filth, misery, disease, and death around. The liquid portion of the sewage after deodorisation will be allowed to flow into the Thames, in a clear and limpid state, free from smell.

All the rainfall would still be allowed to flow into the Thames, through proper constructed channels.

It has been calculated on safe practical data, that these two under-shore tunnels, extending for 20 miles on each shore, from above Battersea to below Barking creek, and the two reservoirs, together with powerful lift pumps, revolving floats, steam-engines, and other working machinery, will be fairly estimated at a cost of two millions sterling, thoroughly well done. At the lowest calculation, the value of the manure (on two and a-half million population) of London and suburbs, may be safely taken at one and a-half million sterling per annum; from which deducting 33 per cent. for the working operations, would have a revenue or profit of a million sterling per annum. So that the whole first cost or outlay would be repaid in two years' receipts of clear profit; and effective intercepting sewers be placed in their best position, the lowest practical level under the river shores, instead of beneath the streets and houses, where the cost of construction of the sewers must be necessarily much greater, the difficulty of back draining the property on river sides very great, independent of the interruption to traffic to already over-crowded streets, whilst the sewers are in construction.

The debris or rubbish of the two under-shore tunnels is proposed to be removed to the Isle of Dogs; where its being deposited and spread would raise this malarious marsh to a good building land, and increase its value tenfold, besides benefiting the health of the metropolis.

All the present constructed and future street sewers would discharge their contents with a rapid fall into the tunnels. Shafts of access would be made, and means provided (when expedient) for scouring through the conduits with the high tide waters, and removing any obstruction to free flow of sewage to their points of final discharge.

By this mode of under-shore tunnelling ample provision is made for increase of population, no property is disturbed or would require a purchase (except for reservoirs or works), no interruption to traffic of river in the construction, no back-flowing sewers required from river side properties, and no cause for complaint from inhabitants of Woolwich, Gravesend, or other places beyond Barking, if the sewage is deodorised.

Immediately connected with these two main conduit or sewage tunnels on each side of the Thames, from above London-bridge to Battersea (or Fulham) bridge, Mr. W. Austin proposes the formation of a boundary width, or limit to the waters of the Thames, commencing in following ratio and order of succession:—

	Width from Shore to Shore.	
London-bridge	700 ft.	Being total width of 760 feet allowing 30 feet width on each shore for a landing-pier.
Southwark-bridge	700 ft.	Present full width without piers.
Blackfriars-bridge	750 ft.	Increased widths to allow for the bend or sweep of the river.
Waterloo-bridge	800 ft.	
Hungerford-bridge	800 ft.	
Westminster-bridge.....	750 ft.	
Vauxhall-bridge	700 ft.	
Chelsea-bridge	700 ft.	
Battersea-bridge	700 ft.	

By this arrangement of bounds, a really handsome river of 750 feet average width would be substituted for filthy mud-banks on an unregulated space; and the bed of the river would never be seen by the new arrangements, and barges, boats, vessels, and steamboats would, at high or low tide, have sufficient depth of water to load or unload at all times and seasons, instead of being left stranded on the unsightly and unhealthy mud-banks, as vessels and barges now are from tide to tide, between ebb and flow.

A great commercial advantage would also be gained by the formation of a splendid line of river fronts, such as wharves, docks, piers, jetties, and promenades, which could be constructed over the present waste area o mud-banks, the new boundary river walls having the sewage conduit-tunnels for their base or footings, from London bridge up to Battersea-bridge.

A highly remunerative revenue and profit would be derived in the shape of yearly or leased rentals of wharfs, docks, jetties, piers, &c., and would justify a liberal outlay of capital, if properly set out and arranged for commercial working.

Independent of the commercial advantages to merchants and tradesmen on both sides of the river, the Surrey side would be peculiarly benefitted, as the frequent overflows of high tides on this low-lying district would be prevented by the new ranges of raised boundary walls, acting as checks to the overflow.

It is stated that water has been discovered at Tameina, near Bethna, on the edge of the southern Desert, after boring to a depth of about 200 feet. This is the first well bored on the European plan; and until now the place has always suffered much from drought.

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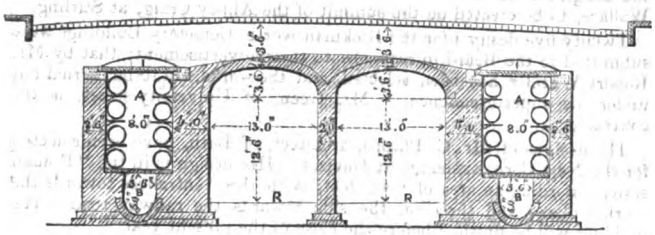
METROPOLITAN SUBWAY.



This scheme has been submitted to the Metropolitan Board of Works by Mr. John Hawkshaw, C.E. It is proposed to construct under the new street from Cheapside to Long-acre, two subways, each containing an up and down line of rails. On reaching Long-acre, it is proposed to continue one line under Long-acre, Leicester-square, Coventry-street, and Piccadilly to Hyde-park Corner. The other line from Long-acre under Endell-street, High-street St. Giles's, and Oxford-street to Cumberland-gate.

Thus the two lines of subrailway will proceed from Cheapside, side by side, under the new street to the corner of Bow-street and Long-acre, then fork or branch off to the northern and southern sides of Hyde-park.

Contiguous to the subrailways, and on each side, it is proposed to build chambers to hold the gas and water-mains, telegraphic wires, &c.; to be of such height that persons may pass along to move the pipes therein. The sewers may be constructed under these chambers, but apart from, and impervious to, the subway.

By the new street, constructed on a level by a viaduct over Farringdon-street and avoiding the Holborn and Fleet-hills, a new passage would be afforded to the public, and by the subrailway a larger portion of the vast crowds passing east and west would be carried from the existing thoroughfares. Great interruption to the existing traffic has occurred when the gas and water companies, or the late Sewers Commissioners were and are obliged to dig up the main highways, to touch their pipes or get at their sewers. By the proposed two chambers under the new street on each side of the subrailway, but separated therefrom, the gas and water pipes and the sewers, would be carried and passed along without interrupting the surface of the street above. This plan would effect a large annual saving to the adjacent parishes in cost of paving alone, as well as to the gas and water companies in leakage, corrosion of pipes, and facilities in getting at and moving their mains. The sewers can also be easily approached from the same chambers, as well as at the numerous stations along the railway, whilst no difficulty exists in keeping them well ventilated. On these lines of route a system of telegraphic communication may, at a very trifling cost, be established, which might afterwards be extended to all parts of the metropolis, connecting together the various public offices, and bringing into immediate correspondence the commercial and private establishments of the City and West-end. There has been matured a complete system of telegraphic communication for this especial purpose, through which, were it adopted, any public or private establishment might have the exclusive use of a magnetic elegraph between any two or more points in the metropolis or suburbs, on payment of a small annual rent, not exceeding 2*l.* per mile per annum.

NOTES OF THE MONTH.

On the evening of the 16th ult. the annual meeting and *conversazione* of the Architectural Museum was held at its rooms in Canon-row, Westminster. The number of visitors was unusually large, including D. Roberts, Esq., R.A., Henry Cole, Esq., C.B., S. C. Hall, Esq., the Rev. Canon Wordsworth, Sydney Smirke, Esq., R. W. Billings, Esq., J. H. Parker, Esq., &c. &c. The chair was taken, as on the last occasion, by the President, Earl de Grey, who addressed the meeting in his usual able and friendly manner. The report was read by the Treasurer, Mr. Scott. The claims of the Museum as a national collection, as well as an unequalled field of study, were enforced in speeches by Dr. Wordsworth, Mr. Smirke, Mr. Cole, the Rev. C. Boutell, Mr. Godwin, and Mr. Parker. In addition to the usual contents of the rooms, some portfolios of exquisite photographs were sent for inspection, also a highly finished specimen of wood carving by Mr. Perry, some new designs executed in metal by Hart and Sons, and water-colour drawings by — Webster, Esq. The collection of casts now numbers upwards of 6500 specimens, most of them of the choicest kind, and no inconsiderable portion has been acquired from the continent. A collection of casts from natural foliage, &c. is in course of formation, to afford opportunities for the study of the ornamental art of past ages, side by side with nature herself. Established for the express purpose of providing a school for the *practical* study of architectural art and ornament, by those who realise the practical expressions of the architecture of their own times, the Museum at the same time offers to the general public the means of forming a just estimate of an art in which all are deeply interested.

The British Archæological Association will meet at Bridgewater, from Monday, the 25th inst., to Saturday, the 30th.

The members of the Liverpool Architectural and Archæological Society held their annual meeting and dinner on the 14th ult., at Nichol's Hotel, Eastham; Mr. Samuel Huggins, President, in the chair. The gathering was larger than usual and gave great satisfaction.

From the second annual report of the London Diocesan Church Building Society, just issued, we learn that churches have been consecrated during the year in the parishes of Deptford, Islington, Marylebone, Paddington, St. Martin's-in-the-Fields, and Westminster. The works in progress or about to be commenced under their sanction and assistance amount to seventeen, besides several peculiar grants. Towards the erection of *temporary churches*, grants have been made to the amount of 200*l.*, divided among the parishes of St. Luke, Islington, St. Mary, Newington, and St. Peter, Stepney. 1000*l.* has also been voted towards the purchase of one *site* in St. James' parish, Clerkenwell, where the population is about 12,000, and the church accommodation 600 only. The committee have also been enabled to aid in the providing of *parsonage houses* in two instances, viz. to the Old St. Pancras church, and to the Holy Trinity, Westminster. The society has expended in grants during the past year, 2150*l.*; in loans, 1000*l.*; towards four new churches, four temporary churches, the enlargement of one existing church, and the providing of two parsonage houses. The church accommodation which has thus been provided amounts to 5420 sittings, of which 2414 are free; and the sum of money by which, so far as it is possible at present to calculate it, these grants and loans have been met, is about 10,000*l.*

The growing demand for musical entertainments seems to call for better structures, devoted more exclusively to the illustrations of that art. To meet this desideratum, in some measure, what is called the St. James's Hall Company has been formed at the West-end, for the erection of a most superb Music-hall, to be situated between the Regent's-quadrant and Piccadilly, laterally, and its end boundary to be George-court and Air-street. The site is particularly eligible, and will be held on lease direct from the Crown for a term of seventy-five years. The structure will have four distinct entrances, with frontages in Regent-street and Piccadilly. The promoters of the project propose to erect a grand hall, 134 feet long by 60 feet wide, and 60 feet in height, and two music-halls, one 60 feet by 48 feet, and the other 48 feet by 40 feet, and 23 feet high. Arrangements have also been made to purchase adjoining property in Regent-street, in order to secure a third music-hall, 60 feet long by 40 feet wide, and 30 feet in height, together with other extensive premises which it is proposed to convert into a restaurant and concert-rooms. The company will be formed under the Act passed in the last session of Parliament, which limits the liability of each shareholder to the amount of his subscription only. The estimated capital is put down at 40,000*l.*, with a margin of 5000*l.* for extras, purchase and preliminary expenses. The shares are fixed at 10*l.* each, and the annual expenses for rent, taxes, and management, are computed to be about 2522*l.* The Earl of Granville and H. B. Baring, Esq., M.P., are the trustees; Mr. Owen Jones is the architect selected, whose superior genius will no doubt render it one of the most superbly decorated buildings of the kind in Europe, as it will exceed nearly all similar ones in the kingdom for size.

A minutely finished map of the "Geology and Contours of London and its Environs" has just been published by Mr. R. W. Mylne, C.E., to a scale of 3¾ inches to a mile. It shows a surface extending from Kew to Plumstead Marshes, and from Hornsey to the Crystal Palace, an area of 176 square miles. Besides the contour lines and geological features, many interesting facts relating to public works are recorded, such as the course of canals and level of water at the locks, the lines of railway and their levels, the sectional area of the Thames and its maximum depth at high water at several points, the lineal waterway of all the bridges, &c. The boundaries of the thirty-eight new districts of the Metropolis Local Management Act are also shown. The geological information conveyed in the map is the result of some years' observation and inquiry, not only upon the surface soils, but on the substrata of London, on which subject the author published a series of outline sections in 1850. An unusual amount of care has been bestowed upon the getting up of this map, which is rendered in every way as complete as possible, consistent with clearness; and it is moreover published in two distinct forms, one coloured to distinguish the districts of the Metropolis Local Management Act, and the other to represent the districts and areas supplied by the different water-works' establishments.

The immense works in the bay of Bengal begun in 1848 have been push forward with great vigour. An enormous dam has been carried across the delta; seven navigable channels connect the weir with the coast, immense drains diminish the risk of inundation; eighty miles of embankments restrain the river in its proper bed; a safe harbour is being constructed, and several thousand men are now employed in improving the navigation of the Upper Godavery, and in opening a communication with the sea for 10,000,000 of people. These great results have been obtained at a comparatively small cost. The actual expenditure up to 1853 was only 180,000*l.* producing an increased revenue of 60,000*l.* or an annual profit of 33 per cent. Before the improvements of the delta are completed, double that sum will no doubt

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be expended, and the investment will prove still more lucrative. It is to the Madras government the Indian public are indebted for these vast improvements. Colonel Arthur Cotton, late chief engineer of the Madras presidency, planned the works.

The waterworks at Broomy-hill, Hereford, under Mr. Moxon, the contractor, are very nearly completed. The engine is by Messrs. Simpson and Co., of London. It is on the beam principle, condensing, and working the steam expansively. It is capable of pumping 40,000 gallons of water per hour, raising it 103 feet high, through a 10-inch rising main, 500 feet long. The outlet of the rising main is brought up to the centre of the reservoir, 2 ft. 6 in. above the top-water level. On the lower side of the reservoir—the capacity of which is 4,126,000 gallons—are the two filtering beds, situate 13 feet below its level. In the centre of each filter-bed is a square pedestal, surmounted by a vase, 4 feet high, through which an ornamental jet will play. The sewerage drains will be flushed with water from the reservoir, and the filtered water be preserved entirely for domestic purposes.

A specimen of a new description of street paving has been recently laid down by the parochial authorities of St. George's, Bloomsbury, in Southampton-street. The component parts of this paving appear to be wood and granite, in alternate rows, formed into blocks of about 2 feet in length by 1 foot in width, and 8 inches or 9 inches deep, cemented with asphalte. The wood having been impregnated with creosote is rendered impervious to water, and being combined with stone, the advantages of wood paving for carriage traffic are retained, without the disadvantage of danger to horses, which resulted from its absorption of water during wet weather. The broken granite being hemmed in and cemented, appears to be less liable to that abrasion by traffic which so easily converts it into mud and dust. If these advantages are really here combined, a very important object has been secured.

Donations of materials for the Greenock monument to James Watt have recently been received from the quarries of Giffnock, Ward-hill, Nitshill, and Arden, amounting to 2000 tons. Stones have arrived from Montreal, the Giant's Causeway, the Isle of Man, &c. Valuable contributions are expected from Italy; and Cornwall and Tipperary will add to the mass. A contribution has just arrived in the form of a single stone of large dimensions from the Seneca Quarry, on the Potomac, Maryland, U.S. the gift of Mr Gilbert Cameron. The site of the intended monument is being prepared under the direction of Mr. David M'Intosh, of London.

A wood-planing machine of extraordinary dimensions has lately been manufactured by Messrs. John McDowall and Sons, of Johnstown, near Glasgow. It is capable of working all descriptions of wood, from ¼-inch to 6 inches in thickness, and from 3 inches to 12 inches in breadth, running through at the rate of 50 lineal feet per minute. The operations of planing, thicknessing, feathering, grooving, and jointing, are all performed at once.

By an American process coal-tar is mixed with india-rubber, and the compound, it is said, makes one of the most solid, elastic, and elegant articles that can be found in the market. It resembles polished stone, is as black as coal, needs no finish, and has of itself as hard and exquisite polish as it is possible for any metal to bear. There is said to be no end to the articles into which it can be made. Cabinet-work inlaid and mosaic, ornamental to the parlour and the chamber, is composed of it, as are tape-lines, pencil-cases, brushes, canes, boxes, buttons, spectacle-bows, and an endless variety of articles, so that this new use of rubber is likely, it is said, to work a complete revolution in the arts and manufactures.

COMPETITIONS.

The Weston Super-Mare Improvement Act Commissioners wish to receive plans and specifications for the erection of a new Town Hall over their market place, the cost not to exceed 2000*l*. The designer of the accepted plans to receive a premium of fifteen guineas. Designs to be sent to the clerk of the commissioners, 5, South Parade, Weston Super-Mare, by the 8th September, who will supply a plan of the ground on application.

The Committee of the Canal Association offer a premium of 100*l*. to the author of the best essay on "Present condition and future prospects of Canals and Canal Conveyance, with suggestions as to the points to which attention with a view to improvement, should be principally directed." The competing essays to be sent, by the 31st December next, to Mr. Thomas Wilson, the Honorary Secretary, at the Aire and Calder Navigation Office, Leeds, who will furnish further particulars on application.

The designs of Mr. Robert Down, architect, of Bridgewater, have been selected for the Chapel to be erected at the Cemetery of Dissenters in that town.

Twenty-eight designs were sent in for a chapel to Cheltenham College. The premium of twenty-five guineas has been awarded to Mr Philip Boyce. The directors have however returned to a design previously made by Mr. D. J. Humphris, who was connected with the institution, and have appointed him to carry it out. Their plea is that none of the plans sent in were suited to the site.

It is intended to submit to public competition among native artists, the design for the National Monument to the memory of Sir William Wallace, to be erected on the summit of the Abbey Craig, at Stirling.

Twenty-five designs for the Rickmansworth Cemetery Buildings were submitted to the Board in response to their advertisement; that by Mr. Robert Wheeler has been selected, and the works are to be carried out under his superintendence. Mr. Geen, of University-street, is the contractor.

The designs of Mr. C. Phipps, architect, of Bath, have been selected for the New Corn Exchange at Devizes. His design is in the "Roman style," affording an area of 6000 feet, with three entrances towards the market-place, and three on the side towards the railway road. The building will be finished before the close of the present year.

The corporation of Manchester invite architects to furnish designs and estimates for the erection of a building on the site of the present Shambles in that town, with duplicate fronts to Swan-street and the general market, which are to be of par-front walling with rubbed dressings. The internal arrangements to consist of shops around the boundary walls for butchers, with a gallery over for the accommodation of dealers in miscellaneous articles; the area of the market to be provided with stalls suitable for butchers. The expense not to exceed 4000*l*. Premiums, 30*l*. and 10*l*. Designs to be sent to Mr. J. Heron, Town Clerk, Town-hall, Manchester.

The Royal Hotel, Mall, Clifton, Bristol, which has been left tenantless for so long a time, is at length in process of receiving another form and destination. Various architects having been invited to compete anonymously for the conversion and application of the vast and ornamental edifice, six plans were sent in, to three of which premiums of 20, 15, and 10 guineas were awarded. The successful gentlemen were Mr. J. H. Hirst, Mr. S. B. Gabriel, and Messrs. Pope, Bindon, and Clark. After some consideration, the committee, on the recommendation of Mr. Medland, architect, of Gloucester, who was called in professionally to advise on the decision, determined upon the adoption of Mr. Hirst's design, as more in accordance with the conditions of the scheme they had submitted to the different architects.

The committee appointed to superintend the erection of the Memorial church at Constantinople, are desirous of receiving designs for the same. The style must be a modification to suit the climate, of the "Pointed" or Gothic. The church to be of sufficient capacity to hold, without galleries, 700 persons, and the cost not to exceed 20,000*l*. Premiums, 100*l*. for the first, and 70*l*. and 50*l*. for the second and third, or in case of equality, two prizes of 50*l*. Designs to be sent to the Honorary Secretaries of the Memorial Church, No. 70, Pall-mall, to January 1st.

The Guardians of the Tamworth Union wish to obtain plans and specifications for a new workhouse. Accommodation required for 200 inmates, with wards, yards, and other conveniences; the cost not to exceed 4000*l*. Plans of the site will be furnished by Mr. John Shaw, Clerk to the Guardians, Tamworth, on application. Plans to August 29.

The Londonderry Bridge Commissioners offer a premium of 200 guineas, for the best plans, sections, and specifications for a bridge over the river Foyle, at Londonderry, to be constructed for the joint purposes of ordinary traffic, and carrying a railway across, and also to contain an opening space of from 30 feet to 40 feet wide for the free passage of vessels; the cost not to exceed 80,000*l*. To be accompanied by an estimate stating the gross sum for the entire work, and a scale of prices upon which such gross sum has been arrived at. The plans to be approved of by Sir William Cubitt. A premium of 100 guineas will be awarded to the plan second in merit. Particulars of Mr. A. H. Stewart, Clerk to the Commissioners, Londonderry. Plans to September 1.

To Messrs. Bellamy and Hardy, architects, Lincoln, the Burial Board of Wramby-cum-Brigg, Lincolnshire, have awarded the first premium of 5*l*. 5*s*. for their plan and design No. 1; and also the second prize of 3*l*. 3*s*. for their design No. 2, for the chapels, lodge, and entrance-gates to be erected on the new burial ground. They received also the premium of 5*l*. for their design for laying out the ground.

The designs of Messrs. Aickin and Capes, Mr. George Henderson, and Mr. W. B. Moffat, have been selected by the committe of visitors, appointed under the Act for the establishment of Industrial Schools, for the school to be erected for the juvenile offenders of the county of Middlesex, and the premiums of 150*l*., 100*l*., and 75*l*. have been awarded to those gentlemen accordingly.

APPOINTMENTS.

Mr. Critchett has been appointed assistant secretary to the Society of Arts, London.

The surveyor to the Grimsby Local Board, Mr. Micklethwaite, has resigned, having receive an appointment under Mr. H. Fowler, C.E., who is about to proceed to Algeria with a staff of English and French surveyors, to lay down lines of railway for the French government.

Mr. R. C. Young, builder, formerly of Gateshead, has been appointed town surveyor of Geelong, in the colony of Victoria, at a salary of 300*l*. a year.

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NEW PATENTS.

PROVISIONAL PROTECTIONS GRANTED UNDER THE PATENT LAWS AMENDMENT ACT.

Dated March 29.

768. C. D. Gardissal, Bedford-street, Strand—Improvements in machinery for sweeping streets and other ways. (Communication)

Dated May 14.

1135. W. Pollock, Paisley—Improvements in the treatment or manufacture of ornamental fabrics of the lappet class

1140. A. Maillet, South-street, Finsbury—An improved artificial stone for grinding, sharpening, and polishing

Dated May 15.

1149. J. Y. Simpson, Edinburgh, and W. Thompson, Belfast—Improvements in the manufacture or production of lubricating oil from a new material

1151. R. Foulds and W. Bracewell, Barnoldswick, near Colne, Lancaster—Improvements in power looms constructed on what is called the loose reed principle

Dated May 22.

1224. C. Barreswil, Paris—Improvements in gas-meters

Dated May 28.

1277. O. Whittaker, and C. Wallwork, Hurst, near Ashton-under-Lyne—Improvements in weaving figured fabrics

Dated June 2.

1297. H. Cartwright, the Dean Broseley, Salop—Improvements in the application of steam cocks to steam engines, and in working such engines thereby

Dated June 3.

1323. F. A. Verdeil, Rue St. Sulpice, Paris—Improvements in obtaining a particular green colouring matter from artichokes and thistles

Dated June 4.

1324. J. Briggs, Fleet-street—Improvements in blocks and bricks for building

Dated June 7.

1356. A. Stamm, Buenos Ayres—Improvements in presses for packing, parts of which improvements are also applicable to other presses

1357. A. V. Newton, Chancery-lane—An improved furnace for heating soldering irons. (Communication)

1358. W. E. Wiley, Great Hampton-street, Birmingham—Improvements in the manufacture of metallic pens and pen-holders

1359. W. D. Ruck, Topping's-wharf, and V. Touche, Rathbone-place, Oxford-street—Improvements in the manufacture of paper from fibres not hitherto applied to such purpose

1360. S. Dyer, Bristol—Improvements in reefing, furling, and setting the sails of ships and vessels, also for protecting such sails from wet and other abuses caused by ropes and rigging

Dated June 9.

1361. A. Robertson, Dublin—An improved inkstand

1362. J. B. Howell, Sheffield—Improvements in the manufacture of cast-steel tyres for railway locomotive engine and carriage wheels

1363. C. W. Siemens, John-street, Adelphi—Improvements in engines wherein superheated steam is used

1364. W. Field and E. Jeffreys, Shrewsbury—Improvements in machinery for sewing seed and for distributing manure

1365. R. Ferrier, Jedburgh—Improvements in machinery or apparatus for sweeping and cleansing roads and streets

1366. J. Holdin, Manchester—Improvements in machinery or apparatus for washing rags, which said improvements are also applicable for washing other materials

1367. J. Holdin, Manchester—Improvements in machinery or apparatus for bowking, bleaching, dyeing, and washing textile fabrics or materials

1368. J. H. Johnson, Lincoln's-inn-fields—Improvements in the construction of rails for railways, and in the mode of securing the ends of rails for railways. (Communication)

1369. J. Ellis, Heckmondwike, York—Improvements in the manufacture of muriate of ammonia and carbonate of ammonia, and in converting certain ingredients employed therein, into an artificial manure

1370. B. Smith and W. Kalthoff Gemünd, near Cologne—Improvements in economising fuel in the locomotive and other steam engines

1372. R. A. Brooman, Fleet-street—Improvements in ladies wearing apparel. (Communication from P. M. Herbert, Paris)

Dated June 10.

1373. T. Skaife, Vanbrugh House, Greenwhich—Spring folding camera shutters for the more speedy and convenient mode of taking photographic pictures than has been hitherto adopted

1374. H. Wagner, Everitt-street, Russell-square—Improvements in beds and mattresses and in similar articles of bedding

1375. R. A. Brooman, Fleet-street—Improvements in printing shawls and other fabrics, and in the machinery employed therein. (Communication from M. Herrmann)

1376. W. Brooks, Chancery-lane—Improvements in the treatment of corn. (Communication)

1377. C. Pietroni, London-wall—Improvements in printing on cloth and other fabrics. (Communication from G. Bossi, Vienna)

1378. P. M. Parsons, Duke-street, Adelphi—Improvements in the permanent way of railways

1379. C. R. Cheshire and J. Betteley, Liverpool—Improvements in the manufacture of anchors

1380. A. E. Preut, Paris—Warming railway and other vehicles

1381. A. V Newton, Chancery-lane—An improvement in projectiles for ordnance. (Communication)

1382. W. Wilson, Newcastle-upon-Tyne—Improvements in machinery for pulling the hair from coney and other skins. (Partly a communication)

Dated June 11.

1383. H. B. James, Derby—Improvements in moulding metallic castings

1384. W. H. Westwood, T. Wright, and R. Wright, Queen's-cross, Dudley—Improved stop or regulating valve

1385. W. Bayliss, Birmingham—A new or improved manufacture of ornamental metallic tubes

1386. J. H. Johnson, Lincoln's-inn-fields—Improvements in the manufacture of safety-paper (Communication from V. Courboulay, Paris)

1387. J. Combe, Belfast—Improvements in machinery for carding, and roving tow and other fibrous substances, part of which improvements is applicable for transmitting motion in other mechanism

1388. A. V. Newton, Chancery-lane—Improvements in breech-loading fire-arms. (Communication)

Dated June 12.

1389. R. A. Brooman, Fleet-street—Improvements in the manufacture of spoons, forks, and other similar articles, and in the machinery employed therein. (Communication from W. Conraetz, Vienna)

1390. J. Elves, Cornhill—Improved machinery for extracting oil from oleaginous seeds. (Communication)

1391. P. W. Hardwick, Gibson-square—An improved manufacture of tickets for railway and other uses

1392. P. Unwin and J. Unwin, Rockingham-street, Sheffield—Improvements in the manufacture of pen and pocket knives

1393. D. Spill, Stepney-green—Improvements in purifying spirits of tar or coal-tar naphtha

1394. J. Fairclough, Liverpool—An improved expander and contractor for dining tables

1395. J. Stenhouse, Upper Barnsbury-street, Islington—Improvements in the preparation of a decolourising material, suitable for the treatment of acid, alkaline, and neutral solutions

1396. C. J. Lewsey, Albion-terrace, Commercial-road East—Improvements in sugar-cane mills

1397. G. L. Stott, St. George's, Gloucester—Improvements in purifying gas

Dated June 13.

1398. T. Cowburn, Manchester—Improvements in valves for reducing the pressure of steam or other liquids or fluids

1399. W. Massey, Manchester—Improvements in looms for weaving

1400. C. J. Dumary, Paris—Improvements in machinery to be used for manufacturing shoes and boots

1401. W. R. Whitmore, Cambridge-terrace, Clapham-road—Improvements in multitubular steam-boilers

1402. W. Mason, Pembroke-dock—An improved rowlock for boats

1403. J. Le Cappelain, New Bridge-street, Blackfriars—Improvements in machinery for bending sheet iron into corrugated forms for constructing beams. (Communication)

1404. S. de Jong, New Hampstead-road—Improvements in warming and ventilating apartments and buildings

1405. W. Jacot, Molyneux-place, Water-street, Liverpool—Improvements in fire-arms. (Communication)

1406. P. A. Lecomte de Fontainemoreau, South-street, Finsbury—Improvements in ship-building. (Communication)

Dated June 14.

1407. H. Mège, Paris—Improvements in the manufacture of bread

1408. J. Bunnett and J. G. Bunnett, Deptford—Improvements in the manufacture of sash-bars, columns, and mouldings for building and decorative purposes

1409. J. E. Mechard, Annecy, Piedmont—Improvements in printing or dyeing skeins, tissues, or other textile fabrics of cotton, wool, flax, and other fibrous substances. (Communication from J. P. Vautravers, Annecy)

1411. P. A. Lecomte de Fontainemoreau, South-street, Finsbury—Improvements in metallic packing for stuffing-boxes and pistons. (Communication)

1412. E. A. Aublet, Paris—Improvements in rotary engines

1413. W. Wright, Forth-street, Newcastle-on-Tyne—Improvements in the manufacture of articles of glass and plastic materials by means of pressure

1414. W. Seed, Preston—Improvements in "lap machines," or apparatus used in the preparation of cotton and other fibrous substances for spinning

1415. E. Lidner, New York—Improvements in breech-loading fire-arms

Dated June 16.

1416. J. Sutcliffe and J. Leech, Rochdale—Improvements in machinery or apparatus for opening, cleaning, and preparing cotton, wool, and other fibrous substances

1417. C. Desnos, Bedford-street, Strand—Improvements in furnaces for consuming smoke. (Communication from C. Descos, Paris)

1418. E. Guérin, Paris—A self-acting apparatus for working railway breaks

1419. W. H. Barlow, Derby, and W. R. Woodhouse, Parliament-street, Westminster—Improvements in connecting and securing the ends of rails for railways

1420. J. B. Mannix, Westminster—A method of applying locomotive power to the working of inclines. (Communication)

1421. W. Turner, Tunnicliffe, near Rochdale, G. Hulme, George-street, Rochdale, and H. Blackburn, Milnrow, Rochdale—Improvements in condensing and other carding engines, billies and mules for carding, slubbing, and spinning woollen, cotton, or other fibrous substances

Dated June 17.

1422. J. Gedge, Wellington-street South, Strand—Improvements in building materials. (Communication from E. A. Heurteau, Checy, France)

1423. J. Gedge, Wellington-street South, Strand—An improved pump, reservoir, and apparatus for measuring liquids. (Communication from A. J. Gendry, Dinant, Belgium)

1424. J. Davis, Birmingham—A new and improved method of manufacturing the small coke, commonly called breezes, which said method of manufacture economises heat, and effects the suppression or partial suppression of smoke.

1425. H. Holland, Birmingham—Improvements in the manufacture of umbrellas and parasols

1426. J. Sadler, J. Green, and T. Davis, Birmingham—Improvements in the manufacture of hinges

1427. A. G. Baylis, Redditch, Worcester—An improvement or improvements in needles

1428. J. Elves, Cornhill—An improved dynamometer. (Communication)

1429. J. H. Johnson, Lincoln's-inn-fields—Improvement in the treatment of sugar canes, and in the apparatus employed therein. (Communication from T. Lespes, Martinique)

1430. F. C. Bakewell, Haverstock-terrace, Hampstead—Improvements in percussion bomb shells. (Communication from J. Lippincott, North America)

1431. W. Baynton, High-street, Bilston, Stafford—Improvements in rolling rails for railways

1432. A. Depai, Rue de Bercy, Paris—Improvements in breaks for railways

1433. C. Nickels, Albany-road, Surrey, and J. Hobson, Leicester—An improvement in weaving when Jacquard or other ornamenting apparatus is employed

Dated June 18.

1434. R. L. de Berenger, Enfield—Improvements in nosebags

1435. T. Burton, Padiham, near Burnley—Improvements in machinery or apparatus for sizing and dressing warps, yarns, or threads

1436. W. H. Tucker, Fleet-street—Improvements in locks and latches

1437. M. A. Muir and J. McIlwham, Glasgow—Improvements in looms for weaving

1438. C. Clifford, the Temple—Improvements in boat-lashings, and in blocks and apparatus used for raising and lowering boats and other articles

1440. C. P. Sharpley, Bury's Cottage, Chapel-street, Stockwell—Improvements in paddle-wheels for propelling vessels

Dated June 19.

1441. G. Tillett, Clapham—Improvements in bedsteads

1442. W. Hunt, Tonge, near Middleton, Lancaster—Improvements in machinery or apparatus for polishing and finishing yarns or threads

1443. F. G. Spilsbury, Chaudfontaine, Belgium—Making soda and alum

1444. G. L. Molesworth, Beaufort-buildings, Strand—An improved pendant child's cot

1445. T. Schwartz, New York—An improved brick

1446. G. Pye, Ipswich—An improvement in preparing silk

1447. W. Mills, Lower Craven-place, Kentish-town—Improvements in pianofortes

1448. W. Parsons, Pratt-street, Old Lambeth—Improvements in washing and bleaching woven fabrics

1449. J. D. Damazio, Lisbon—A new process of making illuminating and heating gas by a double distillation without retort. (Communication)

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Dated June 20.

1451. E. H. C. Monckton, Chancery-lane—Improvements in pianofortes
1452. J. T. Pitman, Gracechurch-street—A new method of using the electric current or currents for telegraphic and other purposes. (Communication)
1453. J. Bullough, Accrington, Lancaster—Improvements in looms
1454. A. Sands, Manchester—Improvements in apparatus for signalling and for saving life and property at sea, part of which is applicable to signalling on land
1455. J. Hague, Ashton-under-Lyne—Improvements in machinery or apparatus for manufacturing bands or cords for driving machinery and other purposes
1456. M. T. Crofton, Leeds—An apparatus for inking stamps used by bankers and others
1457. H. Pigott, Glasgow—Improvements in hats and other coverings for the head
1458. S. T. Jones, Royal-circus-street, Greenwich, and J. Harris, Dolgelly, Merionethshire—An amalgamating machine to extract gold and silver, and to separate iron from crushed mineral ores in water

Dated June 21.

1459. J. B. Howell, Sheffield—Improvements in the manufacture of cast steel tyres
1460. E. Ventré, Paris—An improved carton or box for keeping papers or other articles
1461. G. Davies, Serle-street, Lincoln's-inn—Improvements in apparatus for measuring and indicating the leakage of vessels. (Communication from R. Shaler, Madison, America)
1462. E. R. Hancock, North Frederick-street, Dublin—Improvements in mechanism connected with engines to be worked by steam or other motive power
1463. W. A. Gilbee, South-street, Finsbury—Improvements in locomotion on railroads, part of which improvements are also applicable to ordinary roads. (Communication)
1464. C. Minne and A. Colson, Brussels—Improvement in making bread

Dated June 23.

1465. W. V. Miller, Portsmouth—Improvements in propelling vessels
1466. J. C. L. Lacroix, Heutrégiville (Marne), France—Filthing and shaving the merino, plain satin, and muslin of wool
1467. J. Johnson and W. Blackwell, Ashton-under-Lyne—Improvements in self-acting mules for spinning
1468. G. Gurney, Bude, Cornwall—Improvements for warming and moistening air
1469. R. Roger, Stockton, Durham—Improvements in machinery employed for the cultivation of land
1470. J. A. Longridge, Fludyer-street, Westminster—Improvements in obtaining and applying motive power for the conveyance of minerals, pumping, and other purposes in mines in which motive power is required
1471. G. Riley, The Grove, Lambeth—An improved refrigerator for cooling brewers' and distillers' worts
1472. J. Miller, Drogheda—Improvements in furnaces for more effectually consuming the smoke, and economising the fuel employed therein
1473. H. H. Vivian, B. G. Herrmann, and W. Morgan, Hafod Works, Swansea—Improvements in the manufacture of copper, and in obtaining gold and silver from the ores employed in such manufacture
1474. G. Dyson, Tudhoe Ironworks, Durham—Improvements in the manufacture of iron
1475. I. Atkin and M. Miller, Nottingham—Improvements in machinery for sewing lace and other fabrics
1476. C. Mills, High-street, Camden-town—An improvement in the hammer rails of pianofortes

Dated June 24.

1477. E. Harden and J. Henry, Stockport—Improvements in looms for weaving, and in machinery for communicating motion to looms and other machines
1478. J. Taylor, Hackney-road—An improved vessel for containing chemicals for the generation and disinfecting gases
1479. J. Saxby, Brighton—A mode of working simultaneously the points and signals of railways at junctions to prevent accidents
1480. D. Davies, Wigmore-street, Cavendish-square—Improvements in wheel tyres
1481. J. Harrison, Blackburn, and C Gelderd, Lowmoor, Clitheroe—Improvements in machines for warping and sizing or otherwise preparing yarns or threads for weaving
1482. J. Harrison, Blackburn, and C. Gelderd, Lowmoor, Clitheroe—Improvements in looms for weaving
1483. J. H. Johnson, Lincoln's-inn-fields—Improvements in railway breaks. (Communication from J. B. M. A. Cochot, Paris)
1484. L. Bower, Birmingham—An improvement or improvements in the manufacture of bolts, rivets, spikes, screw blanks, nuts for screws, and washers
1485. S. S. Robson, West-street, Gateshead—Improvements in railway and other carriage breaks
1486. A. Pope, Edgware-road—Improvements in the manufacture of steel
1487. J. E. Lafond, Belleville, Paris—Improvements in lighting
1488. A. V. Newton, Chancery-lane—An improved construction of life-boat. (Communication)

Dated June 25.

1489. C. D. Gardissal, Bedford-street, Strand—Improvements in engraving glass and crystals. (Communication)
1490. H. L. Buff, Fitzroy-square, and F. Versmann, Forest-place, Kingsland-road—An improvement in purifying and softening water
1491. M. Allen, Cavendish-grove, Wandsworth-road—An improvement in arranging and working the slide valves of steam engines
1492. A. Keiller, Dundee—Improvements in the manufacture of articles of confectionery
1493. G. A. Bates, Wigan, Lancaster—Improvements in apparatus for the prevention of accidents in ascending and decending shafts of mines
1494. J. Rohead, Glasgow—Improvements in hats and other coverings for the head
1495. R. W. Chandler, Bow, Middlesex, and T. Oliver, Hatfield, Hertford—Improvements in engines employed for agricultural purposes
1496. T. Scheller, Waedenschweyl, Switzerland—Improvements in obtaining and applying motive power
1497. J. H. E. Mareschal, Paris—Improvements in hydraulic presses
1498. J. Platt and J. Whitehead, Oldham—Improvements in machinery or apparatus for making bricks
1499. J. Kenyon, and R. Kenyon, Bury—An improved fabric to be used in printing and other similar purposes, and a method of joining or connecting the ends of the same
1500. L. Cornides, Trafalgar-square, Charing-cross—Improvements in ornamenting metal, wood, leather, textile fabrics, and other substances

Dated June 26.

1501. G. Durrich, Stuttgart, Wurtemberg—Improvements in gas-burners. (Communication)
1502. J. Gratrix, Preston, Lancaster, and A. Knight, Birmingham—Improvements in apparatus for registering a permanent record of the speed of steam or other engines, which apparatus is also applicable to watchmen's registers, and other similar purposes
1503. H. Waller, Lickhill, near Calne—Improvements applicable to vessels used in the manufacture of cheese
1504. D. White, Winchester-place, Clerkenwell—Improved apparatus for the more perfect combustion of gases, for preventing their escape, and the unnecessary radiation of heat therefrom
1505. D. Macdonald, Glasgow—Improvements in printing textile fabrics and other surfaces
1506. J. Portus, Morpeth, New South Wales—Improvements in wheeled carriages
1507. J. Aikman, Paisley, Renfrew—Improvements in the treatment, cleansing, or finishing of textile fabrics
1508. F. J. L. Malezieux, Paris—Improvements in the preparation of peat, and in the manufacture of the same into fuel, charcoal, and gas. (Communication from M. Gautier)
1509. J. J. Foot, Spital-square—Improvements in weaving narrow fabrics. (Communication)
1510. B. Scariano and R. P. de Villamil, Rue Lepelletier, Paris—Improvements in apparatus for measuring and setting out the forms of garments
1511. W. Hudson, Burnley, and C. Catlow, Clithero, Lancaster—Improvements in looms for weaving

Dated June 27.

1513. A. Shanks, Robert-street, Adelphi—Improvements in machines for drilling, boring, and cutting metals
1514. C. Preller, Lant-street, Southwark—Improvements in unhairing and preparing skins, and in tanning. (Partly a communication)
1515. J. H. Johnson, Lincoln's-inn-fields—Improvements in the production of carbonate of barytes. (Communication from E. P. T. T. Montluc and L. J. Gauthier, Paris)
1516. D. Bethune, Cambridge-terrace, Hyde-park—Improvements in apparatus for separating the more fluid particles from the more solid of various bodies
1517. E. Burnand, Moudon Canton de Vaud, Switzerland.—An improvement in the manufacture of fire-arms

Dated June 28.

1518. G. H. Ormerod, Newchurch, Whalley, Lancaster—Improvements in machinery for brushing and cleaning cotton fabrics
1519. E. Brown, Henry-street Works, Sheffield—Improvements in the casting of sailors' and other pocket-knife handles
1520. G. White, Laurence Pountney-lane, Cannon-street—An improved poultice. (Communication from Dr. Antelme, France)
1521. E. Vincenzi, Turin, Piedmont—Improvements in Jacquard machines
1522. B. G. Sloper, Kentish-town—Improvements in freezing, refrigerating, and cooling, and in the machinery employed therein
1523. R. Reid, Glasgow—Improvements in the treatment or preparation of oils to be used for lubricating
1524. E. Travis, Oldham, Lancaster, and J. L. Casartelli, Manchester—Improvements in machinery or apparatus for testing or ascertaining the lubricating quality of oils or other unctuous substances
1525. W. McAdam, Glasgow—Improvements in the manufacture of articles of clay and such like plastic substances. (Partly a communication)
1526. C. A. Messager-Abit, Rue de l'Echiquier, Paris—Improvements in the treatment of fibrous substances
1527. A. E. L. Bellford, Bedford-street, Strand—Improvements in drying, burning, and cooling bricks, tiles, and other ceramic substances. (Communication)
1528. R. Orrel, Low Moor, North Bierley, Bradford, J. Cleminson, Low Moor, and W. Barraclough, Low Moor, York—Improvements in steam-boilers for preventing explosion thereof
1529. T. F. Henley, Bromley, Middlesex—An improved process for obtaining arrack or spirit from rice or other grain

Dated June 30.

1530. S. J. Goode, Ashton, near Birmingham—Improvements in gas stoves, and the application of the same to the ventilation of buildings
1531. E. Rogers, Abercarn, Monmouth, and H. Mackworth, Clifton—Improvements in cooking, and in apparatus for that purpose. (Partly a communication)
1532. A. V. Newton, Chancery-lane—An improved safety pocket for coats and other garments. (Communication)
1533. H. Brown, Nelson-square, Bermondsey, and J. Bartlett, Little Guildford-street, Southwark—The construction of an easy arm-chair bedstead
1534. C. Moriarty, Nelson-street, Greenwich—Improvements in the construction of tube brushes used in cleaning the tubes of marine, locomotive, and all kinds of multitubular boilers

Dated July 1.

1535. W. H. Ludford, Fredworth, Gloucestershire—Improvements in the manufacture of brooms and brushes
1536. C. W. Goodhart, Woodlands, Middlesex—Improvements in bars or gratings for the security of buildings and other property
1537. F. G. Sanders, Pool, Dorset—Improvements in the manufacture of ornamental floors and other tiles, bricks, slabs and other similar articles
1538. A. Wild, Windsor—Improvements in the manufacture of boots and shoes
1539. J. C. Haddan, Cannon-row, Westminster—Improvements in the manufacture of projectiles, and in firing or discharging them from cannon
1540. J. A. Longridge, Fludyer-street, Westminster—Improvements in the application of mechanical power to ploughing and other field operations of agriculture
1541. D. G. Hope and W. A. Fairbairn, Manchester—Improvements in steam engines
1542. J. L. Davies, jun., and J. Broadbent, Manchester—Improvements in umbrellas and parasols
1543. G. Harvey and A. Harvey, jun., Glasgow—Improvements in machinery or apparatus for boring and drilling
1544. A. V. Newton, Chancery-lane—An improved construction of door lock. (Communication)
1545. G. T. Bousfield, Sussex-place, Loughborough-road, Surrey—Improvements in propelling and steering vessels when the force of water is used. (Communication)
1546. G. E. Dering, Lockleys, Herts—Improvement in galvanic batteries
1547. J. Hay, Hay's Mill, Leith, and J. Hay, Edington-mills, Berwickshire—Improvements in the production of pearl barley
1548. M. H. Loam, Nottingham—Improvements in meters for measuring water and other fluids.

Dated July 3.

1563. J. Pendlebury, Crumpsall, Lancaster—Improvements in machinery or apparatus for bleaching or cleansing textile fabrics or materials
1564. J. Ewing, Cirencester—A new or improved portable receptable for urine and other human secretions
1565. J. C. H. Peirce, Upper North-place, Gray's-inn-road—Improvements in glass chandeliers, lustres, and other such means used in lighting
1566. D. Curwood, Grocers'-hall-court—Improvements in horse rakes, which improved rakes may also be rendered applicable for scarifying land
1567. J. Brown, Leadendall-street—Improvements in hats and caps

Dated July 4.

1568. H. Greaves, Oldham, Lancaster—Improvements in looms for weaving
1569. E. G. Bradford, Torquay—An improved rudder
1570. T. Chandler, Paradise-street, Rotherhithe—A lever cask-stand
1573. J. H. Johnson, Lincoln's-inn-fields—Improvements in machinery or apparatus for cleaning and carding cotton and other fibrous substances. (Communication from G. A. Risler, Cernay, France)

Dated July 5.

1575. E. Travis, Oldham, and J. L. Casartelli, Manchester—Improvements in steam engines.
1576. J. Foss, Manchester—Improvements in machinery for cutting and sawing

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1577. J. Adshead, Manchester—A new application of a known material to be used as a substitute for plastering, painting, papering, whitewashing, and colouring
1578. J. Lewtas and J. Humphreys, Manchester—Improvements in apparatus for holding and releasing cords, chains, bands, or bars
1579. J. A. Manning, Inner Temple—Improvements in the manufacture or production of manure
1580. P. C. J. L. de Combettes, Lyons, France—An improved steam engine
1581. J. M. Letestu, Paris—Improvements in extracting liquids and solid or pasty matters.
1582. T. Smith, Bredfield, Suffolk—Improvements in horse rakes
1583. L. Blackstone, Laurence-lane—Improvements in the manufacture of corks and bungs. (Communication)

Dated July 7.

1584. F. J. Pilliner, Hatfield-street, Blackfriars-road—Improvements in clasps or fastenings for waistbands and other descriptions of bands or straps
1585. E. Millward, Patricroft, Manchester—An improved instrument which may be used as a screw key or gauge
1586. R. Shaw, Portlaw, Waterford—Improvements in obtaining pressure applicable to machinery for preparing and spinning cotton and other fibrous materials and other purposes
1591. G. Sampson, Bradford—Improvements in finishing fabrics
1592. W. C. Cambridge, Bristol—An improvement in the construction of press wheel rollers and clod crushers
1593. H. Smith, Brierley-hill Iron Works, near Dudley, Worcester—An improvement or improvements in the manufacture of harrows
1594. J. Horsfall, Birmingham—An improvement or improvements in the manufacture of wire rope
1595. W. Laing, Denny, Stirling—Improvements in stretching or breadthening woven fabrics
1596. P. C. J. L. de Combettes, Lyons, France—Improvements in rotary steam engines
1597. E. C. Healey, Sidmouth-lodge, Old Brompton, and E. Allen, Strand—An improvement in preparing for use veneers, paper, and other fabrics or sheets made of fibres
1598. H. B. Condy, Battersea—Improvements in defecating or purifying acetic acid and other solutions, also in disinfecting rooms and other places, and in preserving wood
1599. J. H. Noone, Peter-street, Sun-street, Bishopsgate—Improvements in apparatus for retarding and stopping carriages on railways.

Dated July 8.

1600. G. B. Watkins, Godmanchester—Improved apparatus for obtaining infusions or extracts from various substances
1601. W. Youtman, Southampton—Improvements in valves and plugs
1602. J. H. G. Wells, Essex-street, Strand—Improvements in pistons for steam and other motive power engines and pumps in general, and which improvements are also applicable to stuffing boxes. (Communication from E. Rambaud, Lyons, France)
1603. J. H. G. Wells, Essex-street, Strand—Improvements in governors or regulators. (Communication from E. Rambaud, Lyons, France)
1604. F. W. Hoffman, New York, U. S.—An improvement or improvements in breech-loading fire-arms.
1605. H. Page, Whitechapel-road—Improvements in ornamenting or decorating glass
1606. J. F. Belleville, Paris—Improvements in generating and applying steam
1607. R. Martineau and B. Smith, Birmingham—Improvements in taps for drawing off liquids
1608. A. V. Newton, Chancery-lane—Improvements in repeating fire-arms. (Communication)
1609. A. V. Newton, Chancery-lane—An improved fountain pen. (Communication)
1610. A. Herts, Bunhill-row, Finsbury—An improved sheet metal bending and tubing machine. (Communication from W. Webster, Morrisaina, U. S.
1611. A. Gray, Glasgow, and J. Rawson, Bury, Lancashire—Improvements in means or apparatus for lubricating
1612. L. Bayer, Soho—An improved stuffing to be used in place of hair or other substances in which such articles are commonly employed
1613. S. Short, New London, U. S.—Improvements in horse-shoes and shoes for other animals
1614. H. Pigott, Glasgow—Improvements in hats and other coverings for the head
1615. D. Fisher, Ranelagh-road, Thames Bank—A composition for coating metal plates or wheels, used for grinding, sharpening, or polishing

Dated July 9.

1616. W. Adams, Adam-street, Adelphi—Improvements in railway wheels, axles, and axle boxes
1617. A. Crupp, Essen, Prussia—Improvements in the permanent way of railways
1618. R. Bodmer, Thavies Inn, Holborn—Improvements in self-acting apparatus applicable to certain kinds of machines for spinning cotton and other fibrous substances. (Communication from E. Stehelin, Bitschwiller, France)
1619. G. Darlington, Kingston, Jamaica, and J. Darlington, Cannon-street, City—Improvements in the manufacture or production of zinc or spelter
1620. W. Holroyd and W. Noble, Queen's Head, near Halifax—Improvements in machinery or apparatus for cutting wood and stone
1621. D. W. Hayden, Glasgow—Improvements in fastenings for window-shutters
1622. T. Jerome, Great Hampton-street, Birmingham—Improvements in buttons for ornamenting and fastening dresses, as also in loops for attaching or holding buttons on garments while in use
1623. A. W. Williamson, London University, Gower-street—Improvements in obtaining the rosin and sugar of scammony
1624. W. Robertson, Manchester—Improvements in machines for spinning and doubling cotton and other fibrous substances, such machines being of the kind commonly known as mules and twiners or doublers, and in the means of weighting rollers in the same and other machinery
1625. E. Wilson, Eccles-street, Dublin—Improvements in pistons for steam engines driven by steam or any other elastic fluid, which improvements are also applicable to the pistons or plungers of pumps
1626. M. Defries, Houndsditch—Improvements in moderator and other lamps
1627. R. D. Kay, Accrington, Lancaster—Improvements in machinery or apparatus for pressing, straining, sifting, or refining colours and thickened mordants. (Communication)
1628. R. T. Fadon, Sheffield—An improvement in the manufacture of band saws and other endless bands or hoops of metal
1629. H. Adcock, City-road—An improvement in casting iron and other metal

Dated July 10.

1630. F. W. Russell, Aldgate—Improvements in the mode of coupling railway carriages
1631. J. Marsh, Nottingham, and J. Catt, Stepney—Improvements in the manufacture of certain textile fabrics
1632. P. Prince, Derby—Improvements in making moulds for casting railway chairs and other articles
1633. S. Hardacre, Miles Platting, Lancaster—A compound conical spike and spiral double gridder machine for opening, blowing, scutching, and cleaning cotton, wool, and other fibrous substances.
1634. C. W. Lancaster, New Bond-street—An improved method of, or apparatus for, inking, printing, or stamping surfaces. (Communication)
1635. J. Fowler, jun., Havering, Essex, and W. Worby, Ipswich—Improvements in machinery for ploughing and tilling land by steam
1636. S. M. Saxby, Rock Ferry, Chester—Improvements in ascertaining the errors of mariners' compasses

Dated July 11.

1637. R. H. Leadbetter, Glasgow—Improvements in the preparation of flax
1638. R. Harrington, Witham, Essex—Improvements in umbrellas, parasols, walking sticks, whips, &c.
1639. J. Westwood, Lichfield-street, Walsall—Improvements in hand, roof, and other railway lamps, parts of which are also applicable to certain descriptions of oil lamps for general purposes.
1640. T. Charlton and W. Turnbull, Brentwood, Essex—Improvements in steam generators
1641. G. H. Dembinski, Rue Joubert, Paris—An apparatus giving a self-acting motive power, produced by weight, elasticity, compressed water, or any gas whatever
1642. J. B. D. Chevalier and N. Rabouin-O'Sullivan, Paris—A new or improved method of obtaining or preparing printing surfaces, and in printing therefrom
1643. E. H. C. Monckton, Parthenon Club, Regent-street—The application of a means or process for destroying grubsand other insects or animalculæ, or infusoria injurious to plants
1644. A. N. Wornum, Store-street, Bedford-square—Improvements in grand pianofortes

Dated July 12.

1645. B. F. Ortet, South-street, Finsbury—A new metallic composition applicable to the coating of surfaces, and to the moulding and casting of various objects
1646. T. M. Hartwell, J. W. Gladwin, and H. Gladwin, Manchester—Improvements in machinery or apparatus for stretching woven fabrics
1647. W. B. Adams, Adam-street, Adelphi—Improvements in the permanent way of railways
1648. J. Pope, Wincheap-street, Canterbury—Improvements in the application of steam power to ploughing and other agricultural purposes
1649. W. Petrie, Woolwich, Kent—A new porous material for filters and other like articles, and for certain modifications or improvements in the manufacture of the material whereby it is adapted to the formation of vessels of capacity, to be employed as a cement, as a water and acid proof lining, as a preservative coating, and as a substitute for stone and earthenware
1650. A. Herts, Bunhill-row, Finsbury—Improved apparatus for holding material during the operation of sewing. (Communication)
1651. J. Avery, Essex-street, Strand—An improved "plate-holder" for photographs and other purposes. (Communication from Madame Millot, Sault-les-Rethel, France)
1652. J. Rowley, Camberwell, Surrey—Improvements in the manufacture of a material as a substitute for leather

Dated July 14.

1653. P. B. Rassant, Essex-street, Strand—A new mechanical contrivance for transforming an alternate into a continuous circular motion
1654. C. Burrell, St. Nicholas Works, Thetford, Norfolk—Improvements in arranging and rendering portable apparatus suitable for distilling from beet root and other vegetable substances. (Partly a communication)
1655. R. Denby, Hornchurh, Essex—Improvements in horse-rakes
1656. A. V. Newton, Chancery-lane—An improved mode of securing the plastering of ceilings and walls. (Communication)
1657. W. Williams, Dale, Pembroke—Cutting and dressing stone by machinery

Dated July 15.

1659. W. Edwards, Salford, Lancaster—An improvement or improvements in lathes, applicable also in part or on the whole to tools for boring, shaping, cutting, and screwing metals
1660. W. Clibran and J. Clibran, Manchester—Improvements in apparatus or mechanism for regulating and measuring gas
1661. W. Watt, Belfast—Improvements in the manufacture of starch
1662. E. Leigh, Manchester—Improvements in the mode or method of generating steam and applying it for the purpose of obtaining motive power. (Partly a communication)
1663. J. Knowelden, South-street, Southwark-square—Improvements in apparatus for preventing steam boiler explosions
1665. J. H. Johnson, Lincoln's-inn-fields—Improvements in apparatus for consuming smoke to be applied to lamps and gas burners. (Communication from J. B. T. Andry, Paris)
1666. C. B. Blyth and W. P. Butchart, Dundee—Improvements in weaving
1667. G. T. Bousfield, Sussex-place, Loughborough-road, Surrey—Improvements in pumps. (Communication)

Dated July 16.

1671. J. Ford, Preston, and P. Knowles, Bolton-le-Moors—Improvements in machinery for cleaning and preparing cotton and other fibrous substances
1673. R. Morgan, Acton, Middlesex—A pocket-case for containing address cards, stamps, and other similar articles
1677. J. H. Johnson, Lincoln's-inn-fields—Improvements in circular looms. (Communication from J. N. Poivret, Troyes, France)
1679. A. F. Gurlt, Newington-place, Kennington—Improvements in the manufacture of iron and steel

PATENTS APPLIED FOR WITH COMPLETE SPECIFICATION.

1439. C. E. Green, Blandford-street, Portman-square—Improvements in tents, huts, and camp hospitals—June 18
1450. W. Radley, Hill-street, Peckham—Improvements in machinery, apparatus, materials, and processes for preparing and treating auriferous, argentiferous, and cupreous rocks, minerals, and alluviums, parts whereof are applicable to other purposes—June 20
1512. A. Ford, Wellington-square, King's-road, Chelsea—Preparing and dissolving in naphtha or oil of turpentine, vulcanised india-rubber for the purpose of waterproofing, and for all or any of the other purposes for which the same not so prepared and dissolved is now applicable, and especially for the coating of iron ships' bottoms—June 27
1571. T. Key, Brick-lane, Bethnal-green—Improved knife-cleaning machine—July 4
1587. A. L. S. Chenot and E. C. A. Chenot, Clichy-la-Garenne, near Paris—A method of extracting or eliminating extraneous substances from steel sponges—July 7
1588. A. L. S. Chenot and E. C. A. Chenot, Clichy-la-Garenne, near Paris—Improvements in sorting ores or separating metals from each other, and from certain combinations with other substances—July 7
1589. A. L. S. Chenot and E. C. A. Chenot, Clichy-la-Garenne, near Paris—Improvements in machinery for compressing metallic sponges and other substances—July 7
1590. A. L. S. Chenot and E. C. A. Chenot, Clichy-la-Garenne, near Paris—Improvements in apparatus for the reduction of metallic oxides—July 7
1688. F. B. Howell, Lebanon, Ohio, U.S.—Improvement in machinery for making corks (Communication)

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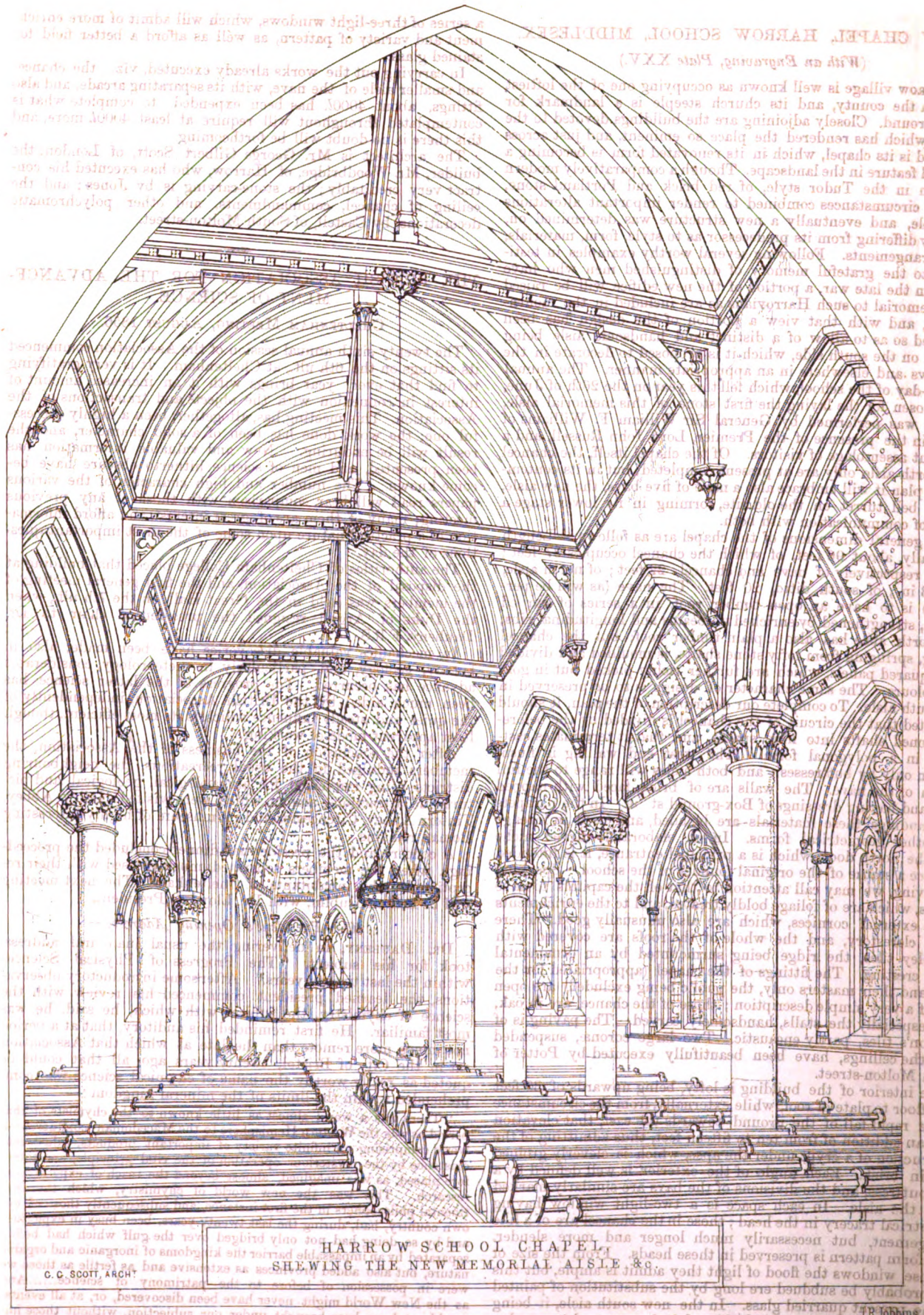

HARROW SCHOOL CHAPEL,
SHEWING THE NEW MEMORIAL AISLE &c.

C. C. SCOTT, ARCHT.

J.R. Jobbins

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NEW CHAPEL, HARROW SCHOOL, MIDDLESEX.

(With an Engraving, Plate XXV.)

Harrow village is well known as occupying one of the loftiest spots in the county, and its church steeple is a landmark for miles around. Closely adjoining are the buildings devoted to the school which has rendered the place so eminent, and just across the road is its chapel, which in its renovated form is becoming a marked feature in the landscape. Though a comparatively modern erection in the Tudor style, of red brick and Portland stone, several circumstances combined to render important alterations desirable, and eventually a new structure was determined on, entirely differing from its predecessor as to style, form, materials, and arrangements. Following several worthy examples in testifying to the grateful memory of distinguished men who have fallen in the late war, a portion of the new edifice will be raised as a memorial to such Harrovians as are included in the mournful list, and with that view a portion of the design has been modified so as to allow of a distinct and handsome aisle being formed on the south side, which it is proposed to decorate in the windows and elsewhere in an appropriate manner. The annual speech-day of the school, which fell this year on the 26th of June, was chosen for the laying the first stone of this memorial aisle, and it was performed by General Sir William F. Williams of Kars, in the presence of the Premier, Lord John Russell, and a brilliant assemblage of visitors. Of the chapel itself, the chancel and north aisle only are at present completed; but in its contemplated plan it will embrace also a nave of five bays, the new aisle, and a bell turret on the old site, forming in its lower stage a lobby of communication with both.

The general dimensions of the chapel are as follows:—Length internally, about 96 feet, of which the chancel occupies 37 feet; width, respectively of nave and chancel, 22 feet; of north aisle, 11 ft. 3 in.; of south ditto, 20 feet. The nave (as will be perceived) is to have an open timber roof, in a series of curved rafters, strengthened by enriched tie-beams and longitudinal ribs; the north aisle has also a plain timber roof; but the chancel ceiling, springing from lofty stone shafts, is moulded and divided into squared panels, which are further richly picked out in gold and colours. The same character of design is to be preserved in the south aisle. To complete our description of the plan, it should be stated that the circuit of the chancel is divided by the beforementioned shafts into nine spaces, and that it terminates eastward in a polygonal form. The west end walling is flush, broken only by buttresses; and both aisles will range to the full length of the nave. The walls are of brick, faced with napped flint, and having dressings of Box-ground stone. In the parapets and bandings these materials are blended, and used in lozenge and other geometrical forms. In an elaborately-carved niche over the north door, which is a principal entrance, it is intended to place a statue of the original founder of the school. Speaking of carving, we may call attention to that of the capitals to nave pillars, which are of foliage boldly treated, and to the enrichments of the external cornices, which are also unusually good. There is no clerestory, and the whole of the roofs are covered with Broseley tiles, the ridge being surmounted by an ornamental metal cresting. The fittings of the chapel (appropriated for the boys and their masters only, the public being excluded) are open and of a very simple description; those of the chancel are in oak, and, especially the stalls, handsomely carved. The paving is of Minton's tiles, partly encaustic. Two large coronæ, suspended from the ceilings, have been beautifully executed by Potter of South Molton-street.

The interior of the building is lofty, being upwards of 30 feet from floor to plate of roof, while externally, from the circumstance of the rapid fall of the ground towards the east, that elevation gains an addition of from ten to fifteen feet, thus admitting of the construction of a crypt under the apse, which is cleverly groined over in brick. Each angle of the exterior is well defined by a bold buttress, and the divisions of the bays are similarly marked along the aisle. In each space is a two-light window having geometrical tracery in the head; those in the chancel are of a like arrangement, but necessarily much longer and more slender. A uniform pattern is preserved in these heads. From the size of the apse windows the flood of light they admit is ample, but this will probably be subdued ere long by the substitution of painted for the present quarried glass. In the new south aisle, it being a wide one, and under a pitched roof, it is proposed to employ a series of three-light windows, which will admit of more enrichment and variety of pattern, as well as afford a better field for stained glass.

In carrying out the works already executed, viz.: the chancel and smaller aisle of the nave, with its separating arcade, and also fittings, about 4000*l.* has been expended: to complete what is contemplated throughout will require at least 4000*l.* more, and this there is no doubt will be forthcoming.

The architect is Mr. George Gilbert Scott, of London; the builder, Mr. Woodbridge, of Harrow, who has executed his contract very creditably; the stone-carving is by Jones; and the ceiling of chancel, commandments, and other polychromatic decorations, by Castell, of South Molton-street.

THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

Cheltenham Meeting, August 1856.

The twenty-sixth annual session of the Association commenced its sittings on the 6th ult., at Cheltenham. It is very gratifying to find that every year brings with it an increased amount of interest in connexion with the objects and transactions of the Association. This meeting has, altogether, been a highly successful one; the work done has been of a solid character, and the result will be enduring. New and valuable information has been presented, and men of science hitherto obscure have become known. The number and high character of the various papers read will bear comparison with those of any previous meeting; many of them are of great interest, and afford information of a practical nature upon some of the most important questions of the day.

The authorities of Cheltenham College placed that building at the disposal of the Association, and the first general meeting of the members was held in the Great Hall, on the 7th ult., when the Duke of Argyll resigned the presidential chair to Dr. Daubeny, F.R.S.

In mechanics valuable discoveries have been made; also in botany, geology, and particularly in meteorology, considerable advance has occurred. The progress of the latter science has been much aided by the British Association, independently of the quiet and steady influence which is its most efficient, though least apparent mode of working.

After the conclusion of the business of the Association, the members indulged in the usual recreations, the neighbouring districts being ransacked for archæological, geological, and picturesque attractions, among which were visited Hailey Abbey, Tintern Abbey, Cirencester and its museum of highly-interesting Roman remains.

A concert and the presidential dinner concluded the proceedings, when the members separated, much pleased with their reception by the inhabitants of Cheltenham. The next meeting will be held at Dublin, with Dr. Lloyd as President.

The President's Opening Address.

Dr. Daubeny, in delivering the usual inaugural address, took for his subject, "The Progress of Physical Sciences within the last twenty years." After some introductory observations, the learned president commenced his review with the science of chymistry, the subject with which, he said, he was most familiar. He first reminded his auditory, that at a period not much more remote than the date at which that Association sat in the City of Bristol, twenty years ago, all that could be quoted as really worthy the name of chymical science was comprehended within the limits of the mineral kingdom:—

"There was a world almost as little known to the chymists of that period as was the Western Hemisphere to the Macedonian conqueror—a world comprising an infinite variety of important products, called into existence by the mysterious operation of the vital principle, and therefore placed, as was imagined, almost beyond the reach of experimental research. This was the new world of chymistry, which the continental philosophers in the first instance, and subsequently those of our own country, had, during the last twenty years, been busy in exploring, and by so doing had not only bridged over the gulf which had before separated by an impassable barrier the kingdoms of inorganic and organic nature, but also added provinces as extensive and as fertile as those we were in possession of before to the patrimony of science.....And as the New World might never have been discovered, or, at all events, would not have been brought under our subjection, without those im-

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provements in naval architecture which had taken place prior to the age of Columbus, so the secrets of organic chymistry would have long remained unelicited but for the facilities in the methods of analysis which were introduced by Liebig. Before his time the determination of the component elements of an organic substance was a task of so much skill as well as labour, that only the most accomplished analysts—such men, for instance, as his lamented friend Dr. Prout in this country, or as the great Berzelius in Sweden—could be depended upon for such a work; and hence the data upon which we could rely for deducing any general conclusions went on accumulating with extreme slowness. But the new methods of analysis invented by Liebig have so simplified and facilitated the process that a student, after a few months' practical instruction in a laboratory, can, in many instances, arrive at results sufficiently precise to be made the basis of calculation, and thus to enable the master mind, which is capable of availing itself of the facts before it, to breathe life into these dry numerical details—just as the sculptor, by a few finishing strokes, brings out the expression of the statue which has been prepared for him by the laborious chiselling of a number of subordinate workmen. ... ..Formerly it had been the rule to set down the bodies which form the constituents of the substances we analyzed, and which had never yet under our hands undergone decomposition, as elementary; but the discovery of cyanogen in the first instance, and the recognition of several other compound radicals in organic chymistry more lately, naturally suggest the idea that many of the so-called elements of inorganic matter may likewise be compounds, differing from the organic radicals above mentioned merely in their constituents being bound together by a closer affinity. It is curious to reflect that while the bold speculations of Democritus had been realised by the Manchester philosopher, the reveries of the alchymists derive something like solid support from the minute investigations of his successors. Indeed, it is not a little remarkable how frequently the discoveries of modern days have served to redeem the fancies of mediæval times from the charge of absurdity. If the direction of a bit of steel suspended near the earth can, as General Sabine has proved, be influenced by the position of a body like the moon, situated at a distance from it of more than 200,000 miles, who shall say that there was anything preposterously extravagant in the conception, however little support it may derive from experience, that the stars might exert an influence over the destinies of man?"

Passing to the practical results bearing on the arts of life which have either been actually deduced, or might be anticipated to accrue from chymical discovery, the president remarked:—

"Of these, perhaps, the most important is the possibility of forming by art those compounds which had been formerly supposed to be only producible by natural processes, under the influence of the vital principle. The last two years have added materially to the catalogue of such bodies artificially produced, as in the formation of several species of alchohol from coal-gas by Berthelot, that of oil of mustard by the same chymist, and the generation of taurine, a principle elaborated in the liver by Strecker. And if the above discoveries should strike you at first sight rather as curious than practically useful, I would remark that they afford reasonable ground for hope that the production of some of those principles of high medicinal or economical value which nature has sparingly provided, or at least limited to certain districts or climates, may lie within the compass of the chymist's skill. If quinine, for instance, to which the Peruvian bark owes its efficacy, be, as would appear from recent researches, a modified condition of ammonia, why may not a Hofmann be able to produce it for us from its elements, as he has already done so many other alkaloids of similar constitution? And thus, while the progress of civilisation and the development of the chymical arts are accelerating the consumption of those articles which kind nature has either been storing up for the use of man during the vast succession of antecedent ages, or else is at present elaborating for us in that limited area within which alone the conditions would seem to be such as to admit of their production, we are encouraged to hope that science may make good the loss she has contributed to create, by herself inventing artificial modes of obtaining these necessary materials. In this case we need not so much regard the exhaustion of our collieries, although nature appears to have provided no means for replenishing them; nor even be concerned at the rapid destruction of the trees which yield the Peruvian bark, limited though they be to a very narrow zone and to a certain definite elevation on either side of the equator. Already, indeed, chymistry has given token of her powers by threatening to alter the course of commerce, and to reverse the tide of human industry. Thus she has discovered, it is said, a substitute for the cochineal insect in a beautiful dye producible from guano. She has shown that our supply of animal food might be obtained at a cheaper rate from the antipodes by simply boiling down the juices of the flesh of castle now wasted and thrown aside in those countries, and importing the extract in a state of concentration. She has pointed out that one of the earths which constitute the principal material of our globe contains a metal as light as glass, as malleable and ductile as copper, and as little liable to rust as silver; thus possessing properties so valuable that, when means have been found of separating it economically from its ore, it will be capable of superseding the metals in common use, and thus of rendering metallurgy an employment, not of certain districts only, but of every part of the earth to which science and civilisation have penetrated. And may I not also say that she has contributed materially towards the advancement of those arts in which an agricultural country like this is especially interested! It is not often that the same individual has reaped a high reputation at once by establishing general principles in science, and by rendering popular their application to practice.. ...But Baron Liebig stands equally distinguished for his ingenuity in devising new methods of analysis, for his originality in propounding great theoretical principles in science, and for his happy talent in applying these principles to purposes of practical utility."

Referring to the discussions which have taken place for some time past between this distinguished foreigner and certain experimental agriculturists in England, with regard to the principles that ought to regulate the measuring of land, Dr. Daubeny proceeded:—

"In so far as concerns the relative advantages of mineral and ammoniacal manures, I presume there is little room for controversy; for, although most soils may contain a sufficiency of the inorganic constituents required by the crop, it by no means follows that the latter are always in an available condition; and hence it may well happen that in most cases in which land has been long under cultivation, the former class of manures becomes, as Baron Liebig asserts, a matter of paramount necessity. Now, that the same necessity exists for the addition of ammoniacal manures can hardly be contended when we reflect that, at the first commencement of vegetable life, every existing species of plant must have obtained its nourishment solely from the gaseous constituents of the atmosphere, and from the mineral contents of the rock in which it vegetated. The only divergence of opinion, therefore, that can arise relates to the degree of their respective utility in the existing state of our agriculture, and to the soundness of Baron Liebig's position, that a plant rooted in a soil well charged with all the requisite mineral ingredients, and in all other respects in a condition calculated to allow of healthy vegetation, may sooner or later be able to draw from the atmosphere whatever else is required for its full development. And does not, I would ask, this latter position derive some support from the luxuriant vegetation of the tropics; where art certainly contributes nothing towards the result? And is it not also favoured by such experiments as those carried on at Lois Weedon in Northamptonshire, where the most luxuriant wheat crops have been obtained for a number of consecutive years without manure of any kind, simply by following out the Tullian system of stirring up and pulverising the soil! How, too, are we to explain that capacity of subsisting without any artificial supply of ammonia which Mr. Lawes is led by his experiments to attribute to turnips and other plants of similar organisation, unless we assume that the power residing in the leaves of absorbing ammonia from the air may render plants, in some cases at least, independent of any extraneous aid! .....Still the practical question remains whether, admitting the theoretical truth of Baron Liebig's position, a larger expenditure of capital will not be required for bringing a given farm into a condition to dispense with ammoniacal manures than for procuring those materials which contain that ingredient ready for use. And here experimental researches, such as those conducted on so extended and liberal a scale by Mr. Lawes and Dr. Gilbert, come in aid of theory. They stand as it were, midway between the abstract principles which science points out to the farmer and the traditional usages with respect to his art which have been handed down to him from one generation to another. They bear the same relation to the farmer which the records of the clinical practice in a large infirmary do to the general principles of medicine expounded by the modern physiologist."

Having awarded a meed of praise to the researches carried on in our own country, and especially those conducted under the auspices of the Highland Society, by Dr. Anderson; at our own Agricultural College, by Professor Voelcker; and through the aid of the Royal Agricultural Society by their consulting chymist, Mr. Way, the President next approached the departments of botany and vegetable physiology. In these branches of natural science he observed that—

"It cannot, perhaps, be said that whole provinces have been added to the domain of the science since the period alluded to, as we have seen to be the case in our review of the progress of chymistry. As long ago as the year 1832 the elder De Candolle, who, if not the most original or most profound of the botanists of his day, was at least the most conspicuous for the wide range of his information, and for his happy talent of imparting it to others, published that admirable work on vegetable physiology which, even at the present time, is capable of serving as a most useful guide in many branches of the subject. And yet what a mass of important information has been brought together since that period! The improvements in the microscope, which have since taken place, render us familiar with particulars relating to the structure and functions of the vegetable creation which the ruder methods of investigation before resorted to would never have revealed to us. We owe to them the interesting discoveries of Brown and Adolphe Brongniart as to

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the mode in which the pollen is brought into immediate contact with the ovules, by means of the tubes which it protrudes by a prolongation of the innermost of its two investing membranes.....While the researches of Brown and others have shown that there is no abrupt line of division in the vegetable kingdom, and that one common structure pervades the whole, the later inquiries of Suminski, Hofmeister, Unger, Griffith, and Henfre, have pointed out several curious and unlooked-for analogies between plants and animals. I may mention in the first place, as an instance of this analogy between plants and animals, the existence of moving molecules or phytosperms in the antheridia of ferns and other cryptogams, borne out as it has been in so remarkable a manner by the almost simultaneous observations of Bischoff and Meissner on the egg, confirmatory of those formerly announced by Barry and Newport, and by the researches of Suminski, Thuret, and Pringsheim, with respect to the ovule of plants. I may refer you also to a paper read at the last meeting of the Association by Dr. Cohn, of Breslau, who, in bringing this subject before the Natural History Section, adduced instances of a distinction of sexes which had come under his observation in the lower Algæa. In like manner a curious correspondence has been traced between the lower tribes of animals and plants in the circumstance of both being subject to the law of what is called alternate generation.. ... To the elder De Candolle we are also indebted for some of our most philosophical views with respect to the laws which regulate the distribution of plants over the globe—views which have been developed and extended, but by no means subverted, by the investigation of subsequent writers; among whom Sir Charles Lyell, in his 'Principles of Geology,' and the younger De Candolle, a worthy inheritor of his father's reputation, in his recently published work on 'Botanical Geography,' have especially signalised themselves. But it is to the late Professor Edward Forbes, and to Dr. Joseph Hooker, that we have principally to attribute the removal of those anomalies which threw a certain degree of doubt upon the principles laid down by De Candolle in 1820, in his celebrated article on the Geography of Plants, contained in the 'Dictionnaire des Sciences Naturelles,' where the derivation of each species from an individual, or a pair of individuals, created in one particular locality, was made the starting point of all our inquiries.....Geology, by pointing out the probability of the submergence of continents on the one hand and the elevation of tracts of land on the other, enables us to explain the occurrence of the same plants in some islands or continents now wholly unconnected, and the existence of a distinct flora in others too isolated to obtain it under present circumstances from without.....An inquiry has been carried on for the last fifteen years under the auspices of and with the aid of funds supplied by this Association, the results of which, it is but fair to say, by no means corroborate the reports that had been from time to time given us with respect to the extreme longevity of certain seeds, exemplified, as it was said, in the case of the mummy wheat and other somewhat dubious instances; inasmuch as they tend to show that none of the seeds which were tested, although they had been placed under the most favourable artificial conditions that could be devised, vegetated after a period of forty-nine years; that only twenty out of 288 species did so after twenty years; while by far the larger number had lost their germinating power in the course of ten."

Having described some of the services rendered to botanical science by the late Professor Forbes, Dr. J. Hooker, and Dr. Thomson, the president continued:—

"The will which confines the variations in the vegetable structure within a certain range, lest the order of creation should be disturbed by the introduction of an indefinite number of intermediate forms, is apparently the same in its motive as that which brings back the celestial luminaries to their original orbits after the completion of a cycle of changes induced by their mutual perturbations; it is the same which says to the ocean, 'thus far shalt thou go, and no further;' and to the winds 'your violence, however apparently capricious and abnormal, shall nevertheless be constrained within certain prescribed limits.'—

'Ni faciat, maria et terras cœlumque profundum
'Quippe ferant rapidi secum, verrantque per auras.'

The law, indeed seems to be nothing else than a direct consequence of that unity of design pervading the universe, which so bespeaks a common Creator—of the existence in the mind of the Deity of a sort of archetype to which His various works have all to a certain extent been accommodated; so that the earlier forms of life may be regarded as types of those of later creation, and the more complex ones but as developments of rudimentary parts existing in the more simple. Here, too, we may perhaps trace an analogy with His dealings with mankind, as unfolded in His revealed word; from which we find that the earlier events recorded are often typical of those more modern, and that Christianity itself is in some sense a development of the Jewish dispensation which preceded it."

Turning his attention next to geology, Dr. Daubeny said,—

"This science has, during the last twenty years, made such rapid strides that those who endeavoured from an early period of life to follow at a humble distance the footsteps of the great leaders in that science, obeying the impulse of such zealous and ardent spirits as the one now, alas! by the inscrutable decrees of Providence, lost to his friends and to science, who constituted the head of what was once called, I hope not too grandiloquently, the Oxford School of Geology, have, if I may judge of others by myself, been often distanced in the race, and when they endeavoured to make good their lost ground found themselves transported into a new and, to them, an almost unknown region. Thus the thorough exploration which has taken place of the Silurian and Cambrian systems, through the exertions of two of our oldest and most valued associates, has added a new province—ought I not rather to say a new kingdom?—to the domain of geology, and has carried back the records of the creation to a period previously as much unknown to us as were the annals of the Assyrian dynasties before the discoveries of Sir Henry Rawlinson."

Among the principles recently regarded as axioms in geology none seemed so little likely to be disputed as this:—

"That the classes of animals and vegetables which possessed the most complicated structure were preceded by others of a more simple one; and that when we traced back the succession of beings to the lowest and the earliest of the sedimentary formations, we arrived at length at a class of rocks the deposition of which must be inferred, from the almost entire absence of organic remains, to have followed very soon after the dawn of creation. But the recognition of the footsteps and remains of reptiles in beds of an earlier date than was before assigned to them, tended to corroborate the inferences which had been previously deduced from the discovery, in a few rare instances, in rocks of the secondary age, of mammalian remains; and this has induced certain eminent geologists boldly to dispute whether from the earliest to the latest period of the earth's history any gradation of beings can in reality be detected."

After touching lightly on the controversy raised among geologists on this question, and adverting to the investigations of Boussingault, Deville, and Bunsen, relative to the gases and other bodies evolved from volcanoes in their various phases of activity, the president glanced cursorily at the nearly allied science of geography. The important undertaking set on foot in connection with this department of knowledge, and the interesting discoveries made in it since the last meeting of the Association, were thus briefly enumerated:—

"Dr. Kane has extended Arctic discoveries through Smith's strait, at the head of Baffin's Bay, to about 3° nearer the Pole. 2. Mr. Kelley has announced the result of several independent surveying expeditions despatched by him to the Valley of the Atrato, with a view to the formation of a great navigable channel through Central America, between the Atlantic and Pacific Oceans. When Humboldt directed attention to this region fifty years since he had only uncertain reports to guide his anticipations; and these surveys have been the first to throw actual light upon this region. 3. An expedition has been despatched to North Australia, for the purpose of exploring the interior and tracing the extent of the northern watershed. Its arrival at the mouth of the Victoria River has been announced. 4. It is proposed by the Geographical Society to despatch an expedition to Eastern Africa, to explore the extent of the inland waters known to exist there, and if possible to discover the long-sought sources of the Nile. 5. The explorations in the Rocky Mountains, by several parties in South America, in the Pacific, and elsewhere, are far too numerous to be further alluded to."

The president then referred to the change which the sentiments of the public have undergone in relation to the claims of physical science—a change, he observed, that afforded equal ground for congratulation with the actual progress made in those pursuits. It was gratifying to find that the attention of the legislature had at length been seriously called to the consideration of what measures of a public nature might be adopted for improving the position of science and its cultivators. The Royal Society had appointed a body of its members to receive suggestions on that subject, and to report upon it, in order that a matured plan to meet this object might be presented to Parliament at its next session. He also cited the School of Mines, the Ipswich Museum, the Oxford Museum, the growing interest taken in that association, together with the increasing recognition of the importance of science in the education of youth, as gratifying signs of advancement. He looked forward, he said, with confidence to the day when the requirements at Oxford in the department of physical science would become so general and so pressing that no institution which professed to prepare the youth it instructed for academical competition would venture to risk its reputation by declining to admit those branches of study into its educational courses. Having eloquently combatted the prejudice entertained against scientific studies on the ground that they are inimical to revealed religion, Dr. Daubeny concluded as follows:—

"We are told that in a future and a higher state of existence the chief occupation of the blessed is that of praising and worshipping the Almighty. But is not the contemplation of the works of the Creator, and the study of the ordinances of the Great Lawgiver of the universe, in itself an act of praise and adoration; and, if so, may not one at least

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of the sources of happiness which we are promised in a future state of existence, one of the rewards for a single-minded and a reverential pursuit after truth in our present state of trial, consist in a development of our faculties, and in the power of comprehending those laws and provisions of nature with which our finite reason does not enable us at present to become cognisant? Such are a few of the reflections which the study of physical science, cultivated in a right spirit, naturally suggests; and I ask you whether they are not more calculated to inspire humility than to induce conceit—to render us more deeply conscious how much of the vast field of knowledge must ever lay concealed from our view, how small a portion of the veil of Isis it is given us to lift up—and therefore to dispose us to accept, with a more unhesitating faith, the knowledge vouchsafed from on high on subjects which our own unassisted reason is incapable of fathoming. 'Let us not then,' to use the words of a living prelate, 'think scorn of the pleasant land. That land is the field of ancient and modern literature, of philosophy in almost all its branches, of the arts of reasoning and persuasion. Every part of it may be cultivated with advantage, as the land of Canaan when bestowed upon God's peculiar people. They were not commanded to let it lie waste, as incurably polluted by the abominations of its first inhabitants; but to cultivate it and dwell in it, living in obedience to the Divine law, and dedicating its choicest fruits to the Lord, their God.'"

Researches at Kertch and in the Crimea. By Dr. D. MACPHERSON, Inspector-Genl. of Hospitals, late of the Turkish Contingent.

Dr. Duncan Macpherson's duties at the late seat of war having led him to Kertch, he was induced, by hearing of the former discoveries of the Russians, to commence excavations, which eventually led to the discovery by him of so many interesting traces of the ancient city of Panticapæum. There are few spots so replete with interest as the Cimmerian Bosphorus, once one of the most flourishing settlements of the ancient Greeks, and the extreme limit in these parts of the colonisation of this wonderful race. Here the archæologists and the searcher in natural history will still find a wide field for exploration. Dr. Macpherson was stationed there from Oct. 1855, to June 1856, but the severity of the weather rendered explorations impossible, and his public duties as principal medical officer over a force of 20,000 men so continually occupied his time that he was unable to prosecute his researches. The present town of Kertch is built close to the site where 500 years before Christ the Milesians, who were of the family of Ionians, formed a colony and founded the city of Panticapæum. The colony of Cherson, near Inkermann, was founded about the same period by the Dorians, a people at rivalry with those of the colony of Miletus. History records that the race denominated the Cimmerians originally inhabited this locality, and that the Tauri, a savage and cruel people, who made offerings and feasts of human victims, and whose dwellings cut out of the solid rock are still seen around Kertch, succeeded them. The Scythians, who appear to have descended from the mountains of Thibet in Tartary, and were probably the ancestors of the present race of Tartars, conquered the Tauri, and became the Tauro-Scythians. Crossing from Pontus, where they held sway, the Milesians expelled the Scythians and founded a kingdom; which, from the salubrity of its climate, the fertility of its soil, and the industrious habits of the colonists, speedily arose in its prosperity, and became, in its palmiest days, the granary of Athens. They dedicated their new city to the sylvan god Pan; because of the abundance of the wine produced the worship of Bacchus became very general among them, and they called the chief city of this colony Panticapæum. It was built on a range of hills, which formed at this period an isthmus into the bay, the acropolis occupying the foreground. The sea has now receded, but a shallow salt water lake still marks the limits to which it formerly extended. No art is needed to add to the beauty of this situation, with the ocean washing it on three sides, and with its heights commanding an extended view of the surrounding country and of the Circassian coast beyond the straits. Even in its ruins, this regal seat of the Bosphorian kings, once the residence of Mithridates the Great, will ever be considered an interesting place for the researches of the historian and antiquary. The range of heights on which Panticapæum was built occupied a plateau from Mons Mithridates, formerly a precipice above the sea (and supposed by Clarke to be the same whence Mithridates threw the body of his son Xiphanes into the waves), extending to a distance of about four miles, and terminating in a huge artificial mound, surrounded by a circular wall of stones placed regularly together without cement. This hill is placed upon the inner vallum or barrier of the Bosphorian empire, and the work stil exists in many places in an entire state, having a ditch in front, and passing across the Peninsula to the Sea of Azoff. Some distance further on is the second vallum or boundary,—the outermost vallum, which separated the Bosphorians from the country of the Tauri, being placed between Arabat and Theodosia. About fifty years before Christ this colony became subject to Rome, or rather to a satrap of the Roman empire, from the circumstance of the Bosphorian kings, who were also rulers of Pontus, having been subdued by this people in Asia. In the year 375 of our era the colony was utterly annihilated by the Huns. Barbarous hordes succeeded one upon another thereafter, until A.D. 1280, when the Genoese became possessors of the soil, and held it until expelled by the Turks in 1473, they being, in their turn, expelled in 1771 by the Russians.

The characteristic features around Kertch are the immense tumuli, or artificial mounds, that abound in this locality, more especially in the second vallum. These sepulchres of the ancient world are found in many places. They are in the form of barrows in England, and cairns in Scotland. Calculated as they are for almost endless duration, they present the simplest and sublimest monuments that could have been raised over the dead. The size and grandeur of the tumuli found in the neighbourhood of Kertch excite astonishing ideas of the wealth and power of the people by whom they were erected, for the labour must have been prodigious and the expenditure enormous. Specimens of the highest Hellenic art have been discovered in these tumuli, such as sculptures, metal, alabaster, Etruscan vases, glass vessels remarkable for their lightness, carved ivory, coins peculiarly pleasing on account of their sharpness and finish, and trinkets executed with a skill that would vie with that of our best workmen. All originals were forwarded to the Hermitage at St. Petersburgh, duplicates being preserved in the museum at Kertch, and these might have been easily secured to England on the investment of the place by the allies, but, with the exception of some basreliefs which, in connection with two other officers, Dr. Macpherson transmitted to the British Museum, the whole of these rare treasures were barbarously made away with. The local tradition is that these tumuli were raised over the remains and were intended to perpetuate the memory of the Kings or rulers who held sway over the colonists, and that the earth was heaped upon them annually on the anniversary of the prince's birth, and for a period of years corresponding to those in which its tenant had held rank or reigned; and to this day the successive layers of earth which was laid on in each succeeding year can be traced, a thin coating of sea-shell or charcoal having been first put down. Dr. Macpherson counted as many as thirty layers in a scarp made in one of these mounds about two-thirds from its base. They are to be seen of all sizes, varying from 10 to 300 feet in circumference, and in height from 5 feet to 150, and are usually composed of surface soil and rubble masonry. Herodotus's reference to these sepulchres is the earliest account which history has recorded of this mode of burial, and the attention of the meeting was particularly drawn to his description of the mode adopted to perpetuate the memory of their deceased princes, as it would be seen that one of the excavations to be referred to corresponded exactly with the description given by him. "The tombs of the Scythian Kings," he states, "are seen in the land of Sberri, at the extreme point to which the Borysthenes is navigable. Here, in the event of a king's decease, after embalming the body they convey it to some neighbouring Scythian nation. The people receive the royal corpse and convey it to another province of his dominions, and when they have conveyed it through all the provinces they dig a deep square fosse and place the body in the grave on a bed of grass. In the vacant space around the body in the fosse they now lay one of the king's concubines, whom they strangle for the purpose, his cupbearer, his cook, his groom, his page, his messenger, fifty of his slaves, some horses, and samples of all his things. Having so done, all fall to work, throwing up an immense mound, striving and vieing with one another who shall do the most." The Greeks, who always respected the religion of the countries they had conquered, and who, in process of time, imbibed to a certain extent their customs and observances, appear to have adopted this Scythian mode of burial. Instead, however, of placing their magistrates or rulers in "a deep, square fosse" dug in the earth, they built tombs, and over these raised the conical hill.

All, or nearly all, of these tumuli have been examined. The Genoese explored the largest and most valuable, and the Russian

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government have also carried on explorations with much success. Selecting those which promised best, assisted by Major Crease, Royal Engineers, Dr. Macpherson has carefully explored these tumuli. In some the tomb was found above the natural surface, and in some beneath it. Some were arched in the Egyptian, others in the modern style. Square flags resting on each other in the centre, and supported by a niche in the side wall, supported a few; others had flat roofs, while occasionally no masonry was discovered. Fragments of bracelets, which were exhibited in the room, were found in one of the tumuli. Having descended many feet under the natural surface, he came upon the bed of ashes. The bones of a horse, human skeleton, and other remains were also met with; and on removing the masonry, fibulæ and bronze coins were picked up in niches between the stones. Having worked at this tumuli for two months without success, he turned his attention to Mons Mithridates. The whole of this hill, from its base to its summit, and the spur extending from it to a distance of three miles, is composed of broken pottery and *débris* of every description to a depth of from 10 to 100 feet over the natural clay hill. The height and size of this Milesian work are so enormous that it is scarcely possible to believe it to be the result of human labour, and it must have been the work of ages to have conveyed the surface soil from the plains below to raise it and the neighbouring heights to the present elevation. On the top of this hill is a rude chair, cut out of the rock, and a hollow resembling a sacrificial altar. He commenced his operations on the sides of these rocks and came to excavations cut out of the stones, and probably the abode of the Tauri, and which had been converted into tombs by the Milesians. These tombs had, however, been explored; but he secured several specimens of the handles of amphoræ, with the names of Greek magistrates stamped thereon, and a few coins with the effigy of Pan, or the Greek ruler for the time being, represented thereon, with the figure of a griffin, which was the emblem of the city, on the reverse. Not far from Mons Mithridates he came upon a portion of an aqueduct which probably conveyed water to the acropolis. It was formed of concave tiles, and one of them he exhibited to the meeting. After describing the result of some of his labours, he proceeded to state that beneath an extensive sloping artificial tumulus, running at right angles with the ridge, extending northwards from Mons Mithridates, he came upon a mass of rubble masonry, beyond which was a door leading to an arched chamber, built under the side of the mound. This led to a larger chamber, which was also arched. The walls of the larger chamber were marked off in squares, with here and there flowers, birds, and grotesque figures. Over the entrance of this chamber were painted two figures of griffins rampant. Two horsemen—one a person in authority, and the other his attendant carrying his spear—were rudely sketched on one of the walls. After some exploration, the skeleton of a horse was found, near which lay a human skeleton; and, continuing his researches, he struck upon a tomb cut out of the solid rock. Not far from this a smaller excavation in the rock was discovered, and, clearing the surface, the rock was found to be hewn out three feet in width and twelve in length. Here he came upon the skeleton of a horse, and, a few feet further on, an upright flag four feet high was found placed over the entrance of a tomb cut out of the calcareous clay. The tomb was of a semicircular form, and he found, on entering, that the floor was covered with beautiful pebbles and shells, such as are now found on the shores of the Sea of Azoff. The dust of the human frame, possessing still the form of man, lay on the floor. The bones had crumbled into dust, and the space occupied by the head did not exceed the size of the palm of the hand, the mode in which the garments enveloped the body, and the knots and fastenings by which they were bound, being easily traceable in the dust. Several bodies were discovered, and at the head of each was a glass bottle, and in one of these bottles was found a little wine. A cup and a lacrymatory of the same material, and a lamp, were placed in a small niche above each body. A coin and a few enamelled beads were placed in the left hand, and in the right a number of walnuts. Other similar tombs were explored, and various specimens of pottery, personal ornaments, vessels of glass, coins, beads, and other objects of interest were found. The whole of these were exhibited in the room, and appeared to excite the greatest curiosity. Dr. Macpherson then gave in detail the progress of his further researches in other tumuli, which were of a most interesting character, and at the conclusion of his paper, was much applauded.

Report of a Committee, consisting of Messrs. A. Cayley, R. Grant, and G. G. Stokes, *to consider the Formation of a Catalogue of Philosophical Memoirs.*

This Committee was appointed—on the occasion of a communication from Prof. Henry, of Washington, containing a proposal for the publication of Philosophical Memoirs scattered throughout the Transactions of Societies in Europe and America, with the offer of co-operation on the part of the Smithsonian Institute to the extent of preparing and publishing, in accordance with the general plan which might be adopted by the British Association, a Catalogue of all the American Memoirs of Physical Science—to consider the best system of arrangement, and to report thereon to the council. The Committee are desirous of expressing their sense of the great importance and increasing need of such a Catalogue. They understand the proposal of the Smithsonian Institute to be, that a separate Catalogue should be prepared and published for America. In the opinion of the Committee, the Catalogue should embrace the mathematical and physical sciences, but should exclude natural history and physiology, geology, mineralogy, and chemistry, which would properly form the subject-matter of a distinct Catalogue or Catalogues. The difficulty of drawing the line would perhaps be greatest with regard to chemistry and geology; but the Committee would admit into the Catalogue memoirs not purely chemical or geological, but having a direct bearing upon the subjects of the Catalogue. The Catalogue should not be restricted to memoirs in Transactions of Societies, but should comprise also memoirs in the Proceedings of Societies, in mathematical and scientific journals, in Ephemerides and volumes of observations, and in other collections not coming under any of the preceding heads. The Catalogue would not comprise separate works. The Catalogue should begin from the year 1800. There should be a catalogue according to the names of authors, and also a catalogue according to subjects,—the title of the memoir, date, and other particulars to be in each case given in full, so as to avoid the necessity of a reference from one catalogue to the other. The Catalogue should, in referring to a memoir, give the number as well of the last as of the first page, so as to show the length of the memoir. The Catalogue should in every case give the date of the memoir (the year only),—namely, in the case of memoirs published in the Transactions of a Society the date of reading, and in other cases the date on the title-page of the volume. Such date should be inserted as a distinct fact, even in the case of a volume of Transactions referred to by its date. The Catalogue should contain a list of volumes indexed showing the complete title, with, in the case of Transactions, the year to which the volume belongs and the year of publication; and in other cases the year of publication, and the abbreviated reference to the work. The reference to works should be given in a form sufficiently full to be easily intelligible without turning to the explanation of such reference. The author's name and date should be printed in a distinctive type, so as to be conspicuous at first sight; and, generally, the typographical execution should be such as to facilitate as much as possible the use of the Catalogue. As to the Catalogue according to the authors' names the memoir of the same author should be arranged according to their dates. As to the Catalogue according to the subjects, the question of the arrangement is one of very great difficulty. It appears to the Committee that the scheme of arrangement cannot be fixed upon according to any *á priori* classification of subjects, but must be determined after some progress has been made in the preliminary work of collecting the title of the memoirs to be catalogued. The value of this part of the Catalogue will materially depend upon the selection of a proper principle of arrangement, and the care and accuracy with which such principle is carried out. The arrangement of the memoirs in the ultimate subdivisions should be according to their dates. The most convenient method of making the Catalogue would appear to be that each volume to be indexed should be gone through separately, and a list formed of all the memoirs which came within the plan of the proposed Catalogue. Such list should be in triplicate: one copy for reference, a second copy to be cut up and arranged for the Catalogue according to the authors' names, and another copy to be cut up and arranged for the Catalogue according to subjects. The Committee have endeavoured to form an estimate of the space which the Catalogue would occupy. The number of papers in a volume of Transactions is in general small, but there are works such as the "Comptes Rendus," the "Astronomische Nachrichten,", the

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"Philosophical Magazine," &c., containing a great number of papers, the titles of which would consequently occupy a considerable space in the Catalogue. Upon the whole, the Committee consider that, excluding America, they may estimate the number of papers to be entered at 125,000, or, since each paper would be entered twice, the number of entries would be 250,000. The number of entries that could conveniently be brought into a page quarto (double columns) would be about thirty, so that, according to the above estimate, the Catalogue would occupy ten quarto volumes of rather more than 800 pages each. It appears to the Committee that there should be paid editors, who should be familiar with the several great branches respectively of the sciences to which the Catalogue relates, but that the general scheme of arrangement and details of the Catalogue should be agreed upon between all the editors, and that they should be jointly responsible for the execution. It would, of course, be necessary that the editors should have the assistance of an adequate staff of clerks. The principal scientific Transactions and works would be accessible in England at the Library of the British Museum and the Libraries of the Royal Society and other Philosophical societies. It would be the duty of the editors to ascertain all the different works which ought to be catalogued, and to procure information as to the contents of such of them as may not happen to be accessible. The Catalogue according to authors' names would be the most readily executed, and this Catalogue, if it should be found convenient, might be first published. The time of bringing out the two catalogues would of course depend upon the sufficiency of the assistance at the command of the editors; but if the Catalogue be undertaken it is desirable that the arrangement should be such that the complete work might be brought out within a period not exceeding three years.

On Isothermal Lines. By PROFESSOR HENNESSY.

After some preliminary remarks as to the general influence of the distribution of land and water on the forms of isothermal lines, the author proceeded to discuss the distribution of these lines in islands. By considering an island situated so as to have its shores bathed by a warm oceanic current, if the influence of direct solar radiation be obstructed, it appears that the isothermals would be closed curves surrounding the centre of the island and having some relation to its coast line. The influence of ranges of mountains, and in general of inequalities in the surface of the island, as well as the modifying action of general winds, and the resulting changes in the shapes of the isothermals, were explained. By the introduction of solar radiation it now follows from the mathematical theory of heat that the entire quantity of heat received by a unit of surface of the island will depend on two principal terms: one, a function of the distance of the point from the coast, and capable of being expressed in some cases as a function of the difference of latitude of that point and the nearest point on the coast; and, secondly, of a term depending on the latitude and on an elliptic function of the second order, having for its modulus the sine of the inclination of the equator to the ecliptic. It hence follows that the effect of solar radiation will be to transport the centres of all the closed isothermals towards the pole of the hemisphere in which the island is situated. Some of the lines may thus ultimately terminate at the coast with their convex sides turned towards the equator, while others may still continue as closed curves in the interior. If the influence of difference of latitude and direct solar radiation were greatly predominant compared to other causes affecting the temperature of the island, the isothermals might all terminate on the coast. If the continents may be considered as immense islands so circumstanced, they become subjects for the application of these views.

Professor Hennessy then proceeded to show that the isothermals of Ireland strictly conformed to his theory. On discussing the observations collected and arranged by Dr. Lloyd in his "Memoir on the Meteorology of Ireland," it appears some of its isothermals are actually closed curves, while others terminate at points on the coast, the shortest being closest to the equator. The physical structure of Ireland, and the difference of nearly 4° between the temperature of the seas bathing its shores and the air above them, rendered it probable, *à priori*, that Ireland should present a good example for the application of the theory. From the general nature of his views, Professor Hennessy anticipated that the discussion of observations in other islands would lead to their further confirmation, and it would ultimately follow that not only are isothermals sinuous in their shapes and not generally parallel to the equator, but that many would be found which do not at all circumscribe the axis which joins the opposite poles of the earth.

Dr. Lloyd made a few remarks in explanation of the nature of the simultaneous meteorological observations in Ireland in 1851, and of the course adopted in their reduction. One of the first results which presented itself, upon a comparison of the monthly means of temperature at the several stations, was the marked defect of temperature at the inland stations, as compared with those on the coast; showing, in a very decided manner, the influence of the gulf stream. The number of inland stations, however, was too small to afford the basis of any deduction as to the actual law of distribution of temperature; and all that could be done was to determine the law of distribution dependent on geographical position alone; and thus, by a comparison of the *calculated* with the *observed* results at the inland stations, to deduce the amount of the deficiency referred to. Accordingly, the observations at the *coast stations* were combined by the method of least squares, and the direction of the isothermal lines in each month deduced, abstracting as far as was possible from the effects due to the distribution of land. From these lines the monthly mean temperatures at the *inland* stations were then *calculated*, and the results compared with those observed; and the result of this comparison, combined with the observations of *sea-temperature* upon the coasts, proved that the effect of the gulf stream was even greater than had been anticipated; the excess of temperature of the sea above that of the air over the land amounting to nearly 4° Fahr. The increase of temperature of the sea surrounding the coasts of Ireland having thus been found to exceed the utmost difference due to geographical position alone, it is plain that the *actual* isothermals must (as Professor Hennessy has observed) be closed curves; and the conclusion showed the importance of observations at the *inland* as well as coast stations, sufficient in number and distribution to furnish the basis for a deduction of their form. This, however, was not possible with the existing data. Dr. Lloyd stated, in conclusion, that the case of Ireland, bathed as it was by the waters of a heated sea, was by no means to be taken as a type of the phenomena of island temperature. It appeared, indeed, from the valuable observations of Dufresny, that the temperature of the sea was *generally in excess* of that of the air above it; but, except in the region of heated currents flowing from a warmer zone, that excess was very small.

Self-registering Mercurial Minimum Thermometer. By Dr. LEE.

Dr. Lee exhibited the instrument, invented by Messrs. Negretti and Zambra, and explained the principle upon which it was constructed as follows:—The thermometer has a bulb of very large size, consequently allowing a tube correspondingly large in the bore for that part forming the scale. On the surface of the mercury enclosed in the tube is placed a small steel needle, pointed at both ends, which forms the index. This conical needle is capable of moving freely in the bore of the tube, and as the mercury descends therein will of course fall with it; but when the mercury ascends in the tube the mercury will pass the lower pointed end of the needle, and rise above the same without raising or moving the needle. This latter will, therefore, remain stationary, and, consequently, its upper point will indicate the lowest temperature to which it has descended during the twelve or twenty-four hours, and will not be affected by any subsequent rise in temperature. To reset the thermometer for future observations it is necessary simply to turn it in such a position that the mercury and needle in the tube will flow into the reservoir at the top; but should the needle not freely flow with the mercury, it may be assisted by a magnet, and readily held there until, by re-turning the thermometer to the upright position, the mercury flows back again into the tube, and then, with the magnet, the needle may be returned to the surface of the mercury ready for future observations. Dr. Lee observed, that one of these thermometers had been in the hands of the Secretary of the British Meteorological Society; another at the Royal Observatory, Greenwich; a third at Mr. E. J. Lowe's observatory, Highfield-house; and others had been used by various members of the British Meteorological Society, all of which had acted most accurately, and in two instances had corrected errors in the alcohol minimums which otherwise would have passed unnoticed.

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New Method of Treating the Doctrine of Parallel Lines. By PROFESSOR STEVELLY.

The author stated that from the days of Euclid to the present all geometricians admitted that Euclid's twelfth axiom was a property to be proved, and not an axiom to be assumed as self-evident; but hitherto no satisfactory and sufficiently elementary proof of it had been adduced. He then showed that, by defining parallel lines to be "when two lines in the same plane were both perpendicular to the same line, they should be called parallel," all the properties of parallel lines as proved by Euclid could be shown to belong to these, by two supplementary propositions. The second of these was, that the line joining any two points along parallel lines, assumed at an equal distance from the line to which both are perpendicular, formed right angles with each of the parallel lines. The author then went through the series of geometrical proofs, which would, however, be unsuited to our report; concluding with the proof of the twelfth axiom of Euclid.

The mathematicians of the Section seemed to admit that the demonstration was rigorous; but doubts were expressed whether it would be suited to elementary teaching, as the proof involved a conclusion arrived at by the method of limits.

On Photography, illustrative of a new Method of Introducing Skies and Artistic effects. By Mr. VIVIAN.

The results exhibited were very pleasing, being similar to those produced by the second stone in double lithography, the original negative giving the details, while the artist's hand, by a subsequent process, regulates the chairoscuro, concentrating the focus of light and shadow in the centre of the picture, and affording means for the introduction of skies, dark water, &c., and reducing the picture produced by the actinic ray to that of the visual, without at all interfering with the truth of the original. The results seemed to give satisfaction to several eminent photographers, who usually despise "cooking," or the union of photography and art.

Models to Illustrate a new Method of Teaching Perspective. Exhibited by H. R. TWINING.

Some of these models serve to demonstrate, in a palpable manner, the true nature and amount of the apparent diminution which takes place as objects recede from the eye; but the chief purpose of the communication was to explain the principle of perspective in such a manner as might enable those who draw to distribute their objects not only in a correct manner, but in one agreeable to the eye. It is an intermediary step between those rules which are demonstrated by diagrams in the usual treatises, and those appearances which characterise natural objects themselves. The chief difficulty in enabling an audience to follow out the principles of perspective when applied to solid objects, is that every individual sees these from a different position, so that such an explanation of the effect observed, as is adapted to one individual, cannot suit another. Mr. Twining's method aims at overcoming this difficulty by placing a bust or image (with which each individual is supposed to identify himself) in the exact spot which the observer ought to occupy, and which thus serves to mark the true focus of the picture.

On the Form of Lightning. By J. NASMYTH.

Mr. Nasmyth said that, observing that the form usually attributed to lightning by painters and in works of Art was very different from that which he had observed as exhibited in Nature, he was induced to call attention to it. He believed the error of the artists originated in the form given to the thunderbolt in the hand of Jupiter as sculptured by the early Greeks. The form of lightning, as exhibited in Nature, was simply an irregular curved line, shooting from the earth below to the cloud above, and often continued from the cloud downwards again to another distant part of the earth. This appearance, he conceived, was the result of the rapidly shooting point of light, which constituted the true lightning, leaving on the eye the impression of the path it traced. In very intense lightning, he had also observed offshoots of an arborescent form to proceed, at several places, from the primary track of the flash.

This communication gave rise to an animated discussion, as to whether or not the flash of lightning was the effect of a rapidly moving point of light or not? and if so, whether the direction was, as stated by Mr. Nasmyth, in nine cases out of ten from the earth to the cloud, or the contrary? Mr. Nasmyth adduced as proof the manner in which leaden pipes were burst, they being bad conductors of electricity, as proofs of his views; of which he instanced one which had been burst in several places, from the bottom to the top; in Edinburgh, during a thunder-storm, the pieces of which Sir J. Leslie had obtained and placed in his physical class-room. On being questioned, however, by some members of the Section, as to how these distant burstings outwards along the pipe gave any indication of the direction, it did not appear there were any decisive marks indicating this.

On the Magnesian Limestone having been formed by the Metamorphism of an ordinary Calcareous Deposit. By H. C. SORBY, F.G.S.

The author's object in this paper was to explain the peculiar physical and chemical characters of this rock by suppositions in accordance with what now occurs in various parts of the globe. He showed, first, that ordinary carboniferous and Devonian limestones have in some cases been undoubtedly changed into dolomite, and that the microscopical structure of the permian limestones indicates that it was originally a similar deposit, afterwards altered by the action of some soluble salt of magnesia. The formation of rock-salt in the superjacent strata is now generally attributed to the concentration of the water of the sea, and in that case a strong solution of magnesian salts would necessarily be produced. The author then suggests that it was the action of such a solution on a subjacent calcareous deposit that changed it to so great an extent into dolomite, that it has been called by pre-eminence the *magnesian limestone.*

A Working Model to illustrate the formation of "Drift Bedding," (a kind of false stratification). By H. C. SORBY, F.G.S.

This model was constructed to show how that when sand is washed along the bottom of water by the current, when the depth becomes so much greater that the velocity is not sufficient to carry it away farther, it is deposited in sloping stratula. By imitating a slow or quicker current, the light and heavy sand were separated, and accumulated in precisely the same manner as is often seen in the rocks of various geological periods, so as to explain completely how drift-bedded structure was formed.

On the Microscopical Structure of Mica Schist. By H. C. SORBY, F.G.S.

In this paper the author described the peculiar microscopical structures, chiefly confining himself to such as throw light on the metamorphic theory. These consist in the form and manner of arrangement of the quartz and mica, which give rise to two very distinct varieties; one analogous to a simple stratified rock, without slaty cleavage, in which crystalline changes had occurred, which he terms *stratification-foliation*; and the other as if the rock had previously been compressed, so that it developed slaty cleavage, which he calls *cleavage-foliation.* These, especially the latter, present such characters as, he contends, could not possibly be explained except by supposing that the rock was originally analogous to clay slate, and had afterwards been altered by crystalline processes. He argued that these had taken place when water was present; for the quartz contains great numbers of minute closed cavities, still more or less full of water, which had been shut up in the solid crystals when they were formed; and that therefore the metamorphism had been produced by an aqueous process, probably accompanied by an elevated temperature, and not by a purely igneous action of partial fusion.

On the Inundations of Rivers. By HENRY HENNESSY, M.R.I.A., Professor of Natural Philosophy in the Catholic University of Ireland.

MY attention was called a few years ago to certain misconceptions which frequently prevail as to the relative importance of obstructions to the flow of rivers, whereby inundations of their banks are caused, or at least greatly promoted. The views I was induced to form by the study of the local phenomena coming under my notice having a more general application, I venture to bring them forward in this short paper.

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It is well known that in general a river in a condition fit to carry off the water falling in its basin should have certain conditions of transverse and longitudinal section. The former should gradually enlarge from the source, and the outline of the latter should be concave upwards, so as to diminish in slope towards the river's mouth. These conditions the natural action of a river upon its bed continually tend to bring about, but many of the operations of man produce effects entirely opposed to this natural tendency of the rivers themselves to form good main drains. It is true, the physical structure of the country through which a river passes may also interpose very serious obstacles to the action just referred to; but here I propose to consider chiefly the action of artificial obstructions. Of these by far the most remarkable are weirs and bridges. Under ordinary circumstances, when the waters of a river are at their usual level, a weir produces a very obvious effect in raising the waters of a river, so that many persons would be at first disposed to regard them as the most important artificial obstructions during a freshet. This arises from confusing the objects for which they are erected with their influence under every possible condition of a river. A weir is designed expressly as an obstacle to the flow of the water, while other obstructions may not be erected for that immediate object; therefore, while the latter only connote an obstructive influence, it is pointedly denoted by the former. Still, in general, when the waters of a river increase, the influence of bridges of more than one arch or pier is far greater than that of weirs. Let us suppose a weir and a bridge of more than one arch, each spanning two different rivers, A and B, at points where the breadth, depth, and velocity of current are precisely the same in both. Let the weir be placed at right angles to the direction of the current in A, that is, in the most favourable position for producing a high swelling. When the water in both rivers is low, the weir will generally produce a greater swelling than the bridge; when the surfaces of both rivers become elevated so that in B the water reaches the tops of the piers of the bridge, the additional sheet of water thus superimposed on that already partly kept back by the bridge will, from its superior mean velocity, be still more dammed backwards, and will consequently tend in a greater proportion to augment the existing swelling. At the same time the corresponding additional sheet of water superimposed on the surface of A, will not meet with any resistance from the weir. When the surface of the water in both rivers becomes still more elevated, so as in B to rise above the springing of the arches of the bridge, the ratio of the contraction to the volume of water passing through will rapidly increase, while at the weir the same ratio will continue to diminish. If, however, the weir should be placed very obliquely to the direction of the current—a position in which weirs are almost always built—a slight rise in the water would produce considerable increase of section, in other words, more space for the passage of the water over the weir, so that in this case the superior obstructive influence of the bridge becomes still more manifest. Thus, although a bridge of several arches and piers is generally less effective than a weir in obstructing the flow of a river in its ordinary state, during extraordinary floods (especially if the arches are numerous and low) the bridge will be far more influential in keeping back the superabundant waters.

These views are very remarkably illustrated by a series of facts which came under my notice in connection with a remarkable flood of the river Lee at Cork. The central portion of that city is situated on a flat island, the surface of which is but little elevated above the level of the two arms of the river by which it is embraced. Under ordinary circumstances it is thus liable to be overflown by a slight increase in the height of the surface of them. Above the city the river is crossed by seven weirs connected with mills and fisheries, and its banks are spanned by nine bridges, of which six are bridges of three arches. The opinion most prevalent as to the influence of all these artificial obstacles to the flow of the river was, that the floods were chiefly caused by the action of the weirs. In November 1853, a flood more than usually calamitous occurred, whereby life and property were destroyed, portions of the quays and one of the most important of the bridges ruined. The force of the current in sweeping over the inundations just above the city was so great as to overturn many walls and earthen fences, and to scour the surface of the roads so as to make them look for some time afterwards like the dried beds of rivulets. Deep excavations were ploughed up in the bed of the river, and large angular blocks of stone were swept along and deposited in heaps wherever there was comparatively still water. So prevalent was the opinion as to the injurious influence of the weirs that notice was formally given, in the usual way, for an act of parliament for their entire removal, despite the opposition such a step would encounter from their proprietors, and the necessarily large outlay that would be required to compensate the destruction of so much valuable property. A careful examination of the facts, and a series of calculations of the comparative effects of the different weirs and bridges, the results of which are contained in a report drawn up by me and printed by the Cork Harbour Commissioners, clearly proved, without any exception, that the bridges and not the weirs were far more important obstacles to the overflowing river. The possibility of some of the weirs situated far above the city being useful, by distributing the waters and preventing their rapid advance, was also pointed out, a view which seems to be now in some measure adopted by the French government with reference to the great inundations of France. The matter was thus immediately set at rest, for the corporation prudently withdrew their notice, and, instead of removing the weirs, have since determined on removing one of the bridges which I had pointed out as most obstructive of all. Two others, which I had placed nearly in the same category, do not come, I believe, under their jurisdiction, being outside the borough. The obvious remedy in such cases will, I understand, be adopted, namely, the substitution of a single flat arch, or a lattice or tubular bridge, for one of several arches. The destruction of bridges of many arches so frequently accompanying floods, seems to point also to a similar remedy; and I cannot hesitate from formally declaring my conviction that many advantages would result by the general adoption, for rivers liable to great fluctuations in the quantity of water passing through their channels, of bridges with a single wide opening, and that spanned either by a very flat arch, or a lattice or tubular beam. Although the invention of these structures has more immediately arisen out of the extension of railways, they appear far more specially applicable to such cases as the crossing of rivers liable to floods.

When a river discharges itself into a tidal estuary, its floods will be affected by the state of the tide, and thus a variable natural obstacle arises to the flow of its waters. If we at first abstract the influence of the fresh water, the tidal wave will move up the channel with a height and velocity which will be an inverse function of the breadth. Whenever the velocity and volume of the tidal wave are greater than those of the river, a very serious augmentation of the height of the fresh water surface may be expected. In ordinary states of most tidal rivers, when the volume and velocity of the fresh water are both inconsiderable, the tidal wave acts precisely like a weir. During a great flood the tidal wave would still act as a weir, but with inferior proportional results, partly from the same cause as that already remarked when speaking of these structures, and partly, also, because the summit of the tidal wave itself might be forced backwards to a lower part of the channel than that to which it would otherwise attain. As the height of any point of a swelling produced by any obstacle to the current of a river decreases with the distance of that obstacle from the point, the height of the flood in the upper parts of the tidal river would be diminished from this cause. But as most rivers widen towards their mouths, the farther down the summit of the tidal wave the greater will be the section for the water to pass over it. These views were illustrated by what took place during the flood of the river Lee. This river discharges itself into a tidal estuary a little below Cork, and in the usual conditions of the river the height of the fresh water is affected by the tides for, at least, a mile above the city. The flood of 1853 attained its maximum height between twelve and one o'clock in the day, and it was high water of an extraordinary spring-tide at half-past five p.m. At this hour the volume and velocity of the fresh water was still so great, that very little alteration in the rapidity of the current was produced on the backwater action of the high tide. Six hours afterwards, at midnight, the fall of the surface of the river was slight, although it was then low water of a spring tide. The height of this tide with the river in its usual state would be such as alone to slightly inundate a small part of the city, as such spring tides have frequently done; it is, therefore, evident that if the summit of the tidal wave had not been to some extent pushed downwards to a wide part of the estuary by the momentum of the fresh water, the combined effect of both might be an inundation still greater than that which had occurred at an earlier period of the day.

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Opening Address of Section G (*Mechanical Science*),
By GEORGE RENNIE, President.

When we assembled last year at Glasgow this section was presided over by Mr. W. J. Macquorn Rankine, a gentleman in every way qualified by his attainments in mathematical knowledge and its application to practical mechanics. He stated that, "although this section bears the title of Mechanical Science, it is well understood that questions of pure or abstract mechanics form no part of its subject.

"That the object of this section is to promote the advancement of science, as applied to practice in the mechanical arts.

"That on the one hand the cultivation of mechanics and other branches of natural knowledge, in a manner purely scientific, has for its object, 1st, to improve the mind of its cultivator intellectually and morally; and 2nd, to qualify him, if possible, for assisting in the advancement and diffusion of knowledge, so that he may be able to investigate how far the laws of particular phenomena are connected with the general economy of nature and the structure of the universe. On the other hand, the cultivation of purely practical knowledge, such as is acquired by experience in business connected with the mechanical arts, has for its object the knowledge of materials and workmanship, with a view to their best and most economical application."

Theoretical mechanics contemplates bodies in an immaterial sense, subject to the laws of equilibrium and motion; and *practical mechanics*, the properties of materials in their solid, fluid, or gaseous states, subject to the same laws; so that while the *science* of mechanics has attained its limits of perfection, its application to the material world is yet very limited. The main object in every inquiry, therefore, is by an analytical process, to separate the various effects which nature has blended together, and to reduce the number of principles to ultimate facts.

Every extension of the powers of calculation, every addition to our stock of knowledge, however small and apparently unimportant, in the properties of materials; every improvement in the most simple machine, is a prelude to further advancement towards mechanical perfection.

The philosophy of machinery, or of its application to manufacture, is therefore an exposition of general principles on which productive industry now denotes every extensive product of art which is made by machinery, with little or no aid from the human hand, but entirely conducted by self-acting machines. "The end of manufacture," says Dr. Ure,* is to modify the texture, form, or composition of natural objects by mechanical or chemical forces acting separately, or combined, or in succession."

Hence, the automatic arts, which are subservient to general commerce, may be distinguished either as mechanical or chemical, according as they modify the external form or internal constitution of their material elements.

The constant aim and tendency of every improvement in machinery is to supersede human labour, and thus diminish the cost of production by substituting feeble and unskilful labour for that of skilful artizans; and although we are not yet arrived at that state of perfection when it can be dispensed with entirely, the great bulk of our enormous annual production is the result of automatic labour.

The man of science, continues the same author, in his 'Philosophy of Machinery,' pre-occupied with theoretical "formulæ of little practical bearing, is too apt to undervalue the science of the factory, though, with candour and patience, he would find it replete with useful applications of the most beautiful dynamical and statistical problems. In physics, he would then see many theorems bearing golden fruit, which had long been barren ground; the phenomena of heat in particular, investigated in their relations to matter in all their varieties."

The measure of temperature on every "scale is familiar to the manufacturer, as well as the distribution of caloric and its habitudes with different bodies—the production of vapours—the relation of their elastic force to their temperature—the modes of using as instruments of power and sources of heat—their most effective condensation—their hydrometric agency—may all be better studied in a week's residence in Lancashire than in a session of any university in Europe; and as to exact mechanical science, no school can compete with a modern cotton mill."

* Philosophy of Manufacture.

Improvements in machinery, therefore, have a threefold being:—

1st. They make it possible to fabricate some articles which, but for them, could not be fabricated at all.

2nd. They enable an operative to turn out a greater quantity of work than he could before—time, labour, and quality of work, remaining constant.

3rd. They effect a substitution of labour (comparatively unskilled) for that which is more skilled.

The object, therefore of manufactures is to modify the productions of nature into articles of necessity, convenience, or luxury, by the most economical and unerring means—mechanically, morally, and commercially—*i.e.*, by labour, science, and capital. The first to move, the second to direct, and the third to sustain when the whole are in harmony, to form a body qualified to discharge its manifold functions by an intrinsic self-governing agency, like those of organic life.

"The man of science," said the late Professor Robinson,* "who visits our great manufactories is delighted with the ingenuity which he observes in every part. The innumerable inventions which come even from individual artizans, and the determined purpose of improvement and refinement which he sees in every workshop, every cotton mill, appears an academy of mechanical science and invention. But the philosopher is mortified to see this ardent spirit so cramped by ignorance of principles, and many of these original and brilliant thoughts obscured and clogged with needless, and even hurtful additions, and a complication of machinery, which checks improvement by its appearance of ingenuity. There is nothing in which this want of scientific education—this ignorance of principle—is so frequently observed as in the injudicious proportion of the parts of machines and other mechanical structures."

If these were his opinions half a century ago, what would he have said, if he had been awakened from his grave, to witness the vast and wonderful progress which mechanical knowledge has since attained. He would have seen the doctrines so clearly laid down by himself, in his papers on the strength of materials, the equilibrium of structures, and the exposition of the steam engine, illustrated by Watt, largely extended in every department. The unobtrusive inquiries into the forge and the furnace, by a Cort and a Mushet, a Neilson or a Crane, and we may now add a Bessemer, pioneers whose labours have added so largely to the resources of their country. He would have seen the properties of the materials so produced investigated in all their varieties by a Hodgkinson and a Fairbairn, and others, all labouring in the same vineyard; and those materials again applied in every form of mechanical combination, whether propelled by animate force or by the all-pervading powers of heat. Again, in the equilibrium of structures, he would have witnessed the balanced arch, the rigid beam, or the suspended chain, or the graceful ship and rapid locomotive—all subjected to the mechanical laws so amplified by himself in their application to the innumerable wants of man. The influence of retarding forces, such as *friction*, developed by so many experiments as to render our knowledge of this subject almost perfect. The motion and equilibrium of fluids, and their application to hydraulic machines of every description. The effects of chemical as well as mechanical combinations, would have suggested many applications of heat to the expansion of fluids and gases, and of the wonders performed by that subtle fluid denominated voltaic, which has hitherto baffled all our researches, but which seems, to our feeble senses, the source of light and life.

All these are the results of experiments guided by science—a science which musters among its cultivators, the names of the most illustrious of the past and present centuries, and from which it would be almost invidious to select, further than the acknowledgment due to a Black, a Watt, a Robinson, a Rumford, a Dalton, an Airey, a Babbage, a Brewster, a Moseley, a Whewell, a Willis, a Joule, and a Thompson, as those who have advocated the cause of mechanical science in our own country; or an Arago, a Dulong, a Poncelet, a Morin, a Regnault, and a Hess, of the Continent. All these philosophers have been powerfully aided by the practical engineers, whose labours have contributed largely to their researches, and to whom this country, as well as science in general, has been so greatly indebted.

* System of Mechanical Philosophy, 4 Vols. Edited by Brewster.

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On the Manufacture of Malleable Iron and Steel without Fuel. By H. BESSEMER.

"The manufacture of iron in this country has attained such an important position that any improvement in this branch of our national industry cannot fail to be a source of general interest, and will, I trust, be a sufficient excuse for the present brief, and, I fear, imperfect paper. I may mention that for the last two years my attention has been almost exclusively directed to the manufacture of malleable iron and steel, in which, however, I had made but little progress until within the last eight or nine months. The constant pulling down and rebuilding of furnaces, and the toil of daily experiments with large charges of iron, had already begun to exhaust my stock of patience; but the numerous observations I had made during this very unpromising period all tended to confirm an entirely new view of the subject, which at that time forced itself upon my attention—viz., that I could produce a much more intense heat without any furnace or fuel than could be obtained by either of the modifications I had used, and consequently that I should not only avoid the injurious action of mineral fuel on the iron under operation, but that I should at the same time avoid also the expense of the fuel. Some preliminary trials were made on from 10 lb. to 20 lb. of iron, and, although the process was fraught with considerable difficulty, it exhibited such unmistakable signs of success as to induce me at once to put up an apparatus capable of converting about 7 cwt. of crude pig-iron into malleable iron in 30 minutes. With such masses of metal to operate on, the difficulties which beset the small laboratory experiments of 10 lb. entirely disappeared. On this new field of inquiry I set out with the assumption that crude iron contains about 5 per cent. of carbon; that carbon cannot exist at a white heat in the presence of oxygen without uniting therewith and producing combustion; that such combustion would proceed with a rapidity dependent on the amount of surface of carbon exposed; and, lastly, that the temperature which the metal would acquire would be also dependent on the rapidity with which the oxygen and carbon were made to combine, and consequently that it was only necessary to bring the oxygen and carbon together in such a manner that a vast surface should be exposed to their mutual action, in order to produce a temperature hitherto unattainable in our largest furnaces. With a view of testing practically this theory, I constructed a cylindrical vessel of three feet in diameter and five feet in height, somewhat like an ordinary cupola furnace, the interior of which is lined with fire bricks, and at about two inches from the bottom of it I insert five tuyere pipes, the nozzles of which are formed of well-burnt fire clay, the orifice of each tuyere being about three-eighths of an inch in diameter; they are so put into the brick lining (from the outer side) as to admit of their removal and renewal in a few minutes when they are worn out. At one side of the vessel, about half way up from the bottom, there is a hole made for running in the crude metal, and on the opposite side there is a tap-hole stopped with loam, by means of which the iron is run out at the end of the process. In practice this converting vessel may be made of any convenient size, but I prefer that it should not hold less than one, or more than five tons, of fluid iron at each charge. The vessel should be placed so near to the discharge hole of the blast furnace as to allow the iron to flow along a gutter into it; a small blast cylinder will be required capable of compressing air to about 8 lb. or 10 lb. to the square inch. A communication having been made between it and the tuyeres before named, the converting vessel will be in a condition to commence work; it will, however, on the occasion of its first being used after relining with fire-bricks be necessary to make a fire in the interior with a few baskets of coke, so as to dry the brickwork and heat up the vessel for the first operation, after which the fire is to be all carefully raked out at the tapping hole, which is again to be made good with loam. The vessel will then be in readiness to commence work, and may be so continued without any use of fuel until the brick lining in the course of time becomes worn away and a new lining is required. I have before mentioned that the tuyeres are situated nearly close to the bottom of the vessel; the fluid metal will therefore rise some 18 inches or 2 feet above them. It is therefore necessary, in order to prevent the metal from entering the tuyere holes, to turn on the blast before allowing the fluid crude iron to run into the vessel from the blast furnace. This having been done, and the fluid iron run in, a rapid boiling up of the metal will be heard going on within the vessel, the metal being tossed violently about and dashed from side to side, shaking the vessel by the force with which it moves. From the throat of the converting vessel, flame will then immediately issue, accompanied by a few bright sparks. This state of things will continue for about fifteen or twenty minutes, during which time the oxygen in the atmospheric air combines with the carbon contained in the iron, producing carbonic acid gas, and at the same time evolving a powerful heat. Now, as this heat is generated in the interior of, and is diffusive in innumerable fiery bubbles through, the whole fluid mass, the metal absorbs the greater part of it, and its temperature becomes immensely increased, and by the expiration of the fifteen or twenty minutes before-named that part of the carbon which appears mechanically mixed and diffused through the crude iron has been entirely consumed. The temperature, however, is so high that the chymically combined carbon now begins to separate from the metal, as is at once indicated by an immense increase in the volume of flame rushing out of the throat of the vessel. The metal in the vessel now rises several inches above its natural level, and a light frothy slag makes its appearance, and is thrown out in large foam-like masses. This violent eruption of cinder generally lasts about five or six minutes, when all further appearance of it ceases, a steady and powerful flame replacing the shower of sparks and cinder which always accompanies the boil. The rapid union of carbon and oxygen which thus takes place adds still further to the temperature of the metal, while the diminished quantity of carbon present allows a part of the oxygen to combine with the iron, which undergoes combustion and is converted into an oxide. At the excessive temperature that the metal has now acquired the oxide as soon as formed undergoes fusion, and forms a powerful solvent of those earthy bases that are associated with the iron. The violent ebullition which is going on mixes most intimately the scoria and metal, every part of which is thus brought in contact with the fluid oxide, which will thus wash and cleanse the metal most thoroughly from the silica and other earthy bases which are combined with the crude iron, while the sulphur and other volatile matters which cling so tenaciously to iron at ordinary temperatures are driven off, the sulphur combining with the oxygen and forming sulphurous acid gas. The loss in weight of crude iron during its conversion into an ingot of malleable iron was found on a mean of four experiments to be 12½ per cent., to which will have to be added the loss of metal in the finishing rolls. This will make the entire loss probably not less than 18 per cent., instead of about 28 per cent., which is the loss on the present system. A large portion of this metal is, however, recoverable by treating with carbonaceous gases the rich oxide thrown out of the furnace during the boil. The slags are found to contain innumerable small grains of metallic iron, which are mechanically held in suspension in the slags, and may be easily recovered. I have before mentioned that after the boil has taken place a steady and powerful flame succeeds, which continues without any change for about ten minutes, when it rapidly falls off. As soon as this diminution of flame is apparent the workman will know that the process is completed, and that the crude iron has been converted into pure malleable iron, which he will form into ingots of any suitable size and shape by simply opening the tap-hole of the converting vessel and allowing the fluid malleable iron to flow into the iron ingot moulds placed there to receive it. The masses of iron thus formed will be perfectly free from any admixture of cinder, oxide, or other extraneous matters, and will be far more pure and in a forwarder state of manufacture than a pile formed of ordinary puddle bars. And thus it will be seen that by a single process, requiring no manipulation or particular skill, and with only one workman, from three to five tons of crude iron passes into the condition of several piles of malleable iron in from thirty to thirty-five minutes, with the expenditure of about one-third part the blast now used in a finery furnace with an equal charge of iron, and with the consumption of no other fuel than is contained in the crude iron. To those who are best acquainted with the nature of fluid iron it may be a matter of surprise that a blast of cold air forced into melted crude iron is capable of raising its temperature to such a degree as to retain it in a perfect state of fluidity after it has lost all its carbon, and is in the condition of malleable iron, which in the highest heat of our forges only becomes softened into a pasty mass. But such is the excessive temperature that I am enabled to arrive at with a properly shaped converting vessel and a judicious distribution of the blast that I am enabled not only to retain the fluidity of the metal, but to create so much surplus heat as to re-melt the crop ends, ingot

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runners, and other scrap that is made throughout the process, and thus bring them without labour or fuel into ingots of a quality equal to the rest of the charge of new metal. For this purpose a small arched chamber is formed immediately over the throat of the converting vessel, somewhat like the tunnel head of the blast furnace. This chamber has two or more openings on the sides of it, and its floor is made to slope downwards to the throat. As soon as a charge of fluid malleable iron has been drawn off from the connecting vessel the workman will take the scrap intended to be worked into the next charge, and proceed to introduce the several pieces into the small chamber, piling them up around the opening of the throat. When this is done he will run in his charge of crude metal, and again commence the process. By the time the boil commences the bar ends or other scrap will have acquired a white heat, and by the time it is over most of them will have been melted and run down into the charge. Any pieces, however, that remain may then be pushed in by the workman, and by the time the process is completed they will all be melted, and ultimately combined with the rest of the charge, so that all scrap iron, whether cast or malleable, may thus be used up without any loss or expense. As an example of the power that iron has of generating heat in this process, I may mention a circumstance that occurred to me during my experiments: I was trying how small a set of tuyeres could be used; but the size chosen proved to be too small, and after blowing into the metal for one hour and three-quarters I could not get up heat enough with them to bring on the boil. The experiment was therefore discontinued, during which time two-thirds of the metal solidified and the rest was run off. A larger set of tuyere pipes were then put in, and a fresh charge of fluid iron run into the vessel, which had the effect of entirely remelting the former charge, and when the whole was tapped out it exhibited as usual that intense and dazzling brightness peculiar to the electric light.

"To persons conversant with the manufacture of iron it will be at once apparent that the ingots of malleable metal which I have described will have no hard or steely parts, such as is found in puddle iron, requiring a great amount of rolling to blend them with the general mass, nor will such ingots require an excess of rolling to expel cinder from the interior of the mass, since none can exist in the ingot, which is pure and perfectly homogeneous throughout, and hence requires only as much rolling as is necessary for the development of fibre; it therefore follows that, instead of forming a merchant bar or rail by the union of a number of separate pieces welded together, it will be far more simple and less expensive to make several bars or rails from a single ingot; doubtless this would have been done long ago had not the whole process been limited by the size of the ball which the puddler could make.

"The facility which the new process affords of making large masses will enable the manufacturer to produce bars that on the old mode of working it was impossible to obtain; while, at the same time, it admits of the use of some powerful machinery whereby a great deal of labour will be saved, and the process be greatly expedited. I merely mention this fact in passing, as it is not my intention at the present moment to enter upon any details of the improvements I have made in this department of the manufacture, because the patents which I have obtained for them are not yet specified. Before, however, dismissing this branch of the subject, I wish to call the attention of the meeting to some of the peculiarities which distinguish cast-steel from all other forms of iron, namely, the perfect homogeneous character of the metal, the entire absence of sand-cracks or flaws, and its greater cohesive force and elasticity as compared with the blister-steel from which it is made, qualities which it derives solely from its fusion and formation into ingots, all of which properties malleable iron acquires in like manner by its fusion and formation into ingots in the new process. Nor must it be forgotten that no amount of rolling will give to blister-steel (although formed of rolled bars) the same homogeneous character that cast-steel acquires by a mere extension of the ingot to some 10 or 12 times its original length.

"One of the most important facts connected with the new system of manufacturing malleable iron is that all the iron so produced will be of that quality known as charcoal iron, not that any charcoal is used in its manufacture, but because the whole of the processes following the smelting of it are conducted entirely without contact with or the use of any mineral fuel; the iron resulting therefrom will, in consequence, be perfectly free from those injurious properties which that description of fuel never fails to impart to iron that is brought under its influence. At the same time, this system of manufacturing malleable iron offers extraordinary facility for making large shafts, cranks, and other heavy masses; it will be obvious that any weight of metal that can be founded in ordinary cast-iron by the means at present at our disposal may also be founded in molten malleable iron, and be wrought into the forms and shapes required, provided that we increased the size and power of our machinery to the extent necessary to deal with large masses of metal. A few minutes' such reflection will show the great anomaly presented by the scale on which the consecutive processes of iron-making are at present carried on. The little furnaces originally used for smelting ore have from time to time increased in size, until they have assumed colossal proportions, and are made to operate on 200 or 300 tons of materials at a time, giving out 10 tons of fluid metal at a single run. The manufacturer has thus gone on increasing the size of his smelting furnaces, and adapting to their use the blast apparatus of the requisite proportions, and has, by this means, lessened the cost of production in every way; his large furnaces require a great deal less labour to produce a given weight of iron than would have been required to produce it with a dozen furnaces, and in like manner he diminishes his cost of fuel blast and repairs, while he insures a uniformity in the result that could never have been arrived at by the use of a multiplicity of small furnaces. While the manufacturer has shown himself fully alive to these advantages, he has still been under the necessity of leaving the succeeding operations to be carried out on a scale wholly at variance with the principles he has found so advantageous in the smelting department. It is true that hitherto no better method was known than the puddling process, in which from 400 to 500 weight of iron is all that can be operated upon at a time, and even this small quantity is divided into homœopathic doses of some 70 lb. or 80 lb., each of which is moulded and fashioned by human labour, carefully watched and tended in the furnace, and removed therefrom one at a time, to be carefully manipulated and squeezed into form. When we consider the vast extent of manufacture, and the gigantic scale on which the early stages of progress is conducted, it is astonishing that no effort should have been made to raise the after processes somewhat nearer to a level commensurate with the preceding ones, and thus rescue the trade from the trammels which have so long surrounded it.

"Before concluding these remarks I beg to call your attention to an important fact connected with the new process, which affords peculiar facilities for the manufacture of cast-steel.

"At the stage of the process immediately following the boil, the whole of the crude iron has passed into the condition of cast-steel of ordinary quality; by the continuation of the process the steel so produced gradually loses its small remaining portion of carbon, and passes successively from hard to soft steel, and from soft steel to steely iron, and eventually to very soft iron; hence at a certain period of the process any quality of metal may be obtained; there is one in particular, which by way of distinction I call semi-steel, being in hardness about midway between ordinary cast-steel and soft malleable iron. This metal possesses the advantage of much greater tensile strength than soft iron; it is also more elastic, and does not readily take a permanent set, while it is much harder, and is not worn or indented so easy as soft iron; at the same time it is not so brittle or hard to work as ordinary cast-steel. These qualities render it eminently well adapted to purposes where lightness and strength are specially required, or where there is much wear, as in the case of railway bars, which from their softness and lamellar texture soon become destroyed. The cost of the semi-steel will be a fraction less than iron, because the loss of metal that takes place by oxidation in the converting vessel is about 2½ per cent. less than it is with iron; but, as it is a little more difficult to roll, its cost per ton may fairly be considered to be the same as iron; but, as its tensile strength is some 30 or 40 per cent. greater than bar iron, it follows that for most purposes a much less weight of metal may be used, so that taken in that way the semi-steel will form a much cheaper metal than any we are at present acquainted with.

"In conclusion allow me to observe that the facts which I have had the honour of bringing before the meeting have not been elicited from mere laboratory experiments, but have been the result of working on a scale nearly twice as great as is pursued in our largest iron works, the experimental apparatus doing 7 cwt. in 30 minutes, while the ordinary puddling furnace makes only 4½ cwt. in two hours, which is made into six separate balls, while the ingots or blooms are smooth even prisms, 10 inches

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square by 30 inches in length, weighing about equal to ten ordinary puddle balls."

Mr. Bessemer's process has, since the reading of his paper before the British Association, been put to a severe practical test, with the most successful result, at Baxter-house, St. Pancras-road, in the presence of several ironmasters, practical engineers, and scientific men resident in the metropolis.

Men like the two Rennies, Nasmyth, and others of minor note, but of great experience as engineers and iron manufacturers, have pronounced emphatically and without qualification in its favour, whilst some, including Nasmyth, declare themselves unable to foresee the whole of the advantageous results calculated to spring from its discovery, not to this country alone, but wherever else it may be brought into use.

In conducting the demonstration, 6 cwt. 3 qr. 18 lb. of molten iron from a furnace was poured into the fire-brick vessel, already described, at twelve minutes past one o'clock, the blast having been applied at a pressure of about 8 lb. per square inch, and continued until twenty-seven minutes past one. The mass of metal began to boil up, and the cinders and other impurities were extruded from the top of the vessel by two apertures provided for the purpose. Showers of brilliant sparks were thrown off during this process, which lasted several minutes; and as the object was to produce a mass of cast steel, rather than continue the process to the extent necessary for making pure iron free from carbon, the vessel was tapped at thirty-six minutes past one and the contents drawn off. Small specimen ingots being first taken the general mass was run into an ingeniously contrived mould concealed in the floor in front of the apparatus, and, after remaining there a few minutes, cooling down, it was raised out of the mould in a red-hot state by an hydraulic ram, and placed upon a weighing-machine. The ingot thus produced, with the two specimen ingots, weighed 6 cwt. Without the aid of fuel this mass of material was converted in twenty-four minutes from crude cast iron as it comes from the blast furnace into steel of fine quality.

The experiment was unanimously pronounced by the company to be perfectly satisfactory. It is a peculiar and important feature in the process that by continuing the boiling a few minutes longer the whole of the carbon still remaining in the mass of metal, and which gives to it the character known as steel, would have been drawn off, and a pure mass of crystalline iron would have been the result.

On the Manufacture of the large Wrought-Iron Gun made at the Mersey Ironworks, Liverpool; and on other large masses of wrought-iron. By W. CLAY.

Mr. Clay commenced by expressing his regret that the circulars ordered to be sent last year to engineers, ironmasters, and manufacturers, by the committee appointed to institute an inquiry into the best means of ascertaining those properties of metals, and effects of various modes of treating them, which were of importance to the efficiency and durability of artillery, were not made more general and public. He was only made aware that day, on looking over the report of the British Association for the past year, that such a committee had been formed, and that they had received opinions from some of the most eminent engineers of the present day, which opinions, with one exception, did not at all coincide with what he was about to record. The first consideration necessary for the manufacture of wrought-iron was to decide the description of iron of which the gun was to be made, and he selected for his experiment a strong clear iron, puddled from the strongest pigs he could obtain, taking care that the iron should be worked as little as possible before it came to be put into the gun. A core was first prepared the full length of the gun, and a certain diameter. This core was intended to be bored out. A series of bars were then packed round the core, and again heated and forged to the proper shape; another series of bars were packed then, and heated and worked perfectly sound; still another and larger series of bars were required, placed longitudinally, and even these were far from the size required. The forging, although larger than any ever previously made, required to be augmented in its diameter at the breach by 12 inches, which was accomplished by two layers of iron placed in such a manner as to resemble hoops. This being all welded round, the forging of the gun was accomplished. The boring was effected in an ordinary powerful lathe, the first bore being 11 inches in diameter, consisting of a drill of 7 inches, and a face-cutter of 2 inches. The second cut ¾-inch on each side, making the bore 12½ inches; and the third, or finishing cut, of ¼-inch, completed the bore He might remark that the boring was not a work of very great expense or labour; on the contrary, the process went on so rapidly that he was unable to prepare the fresh boring heads fast enough. The trunnion hoops were made in separate rings, and were shrunk upon the body of the metal. Having described the manufacture of the gun, Mr. Clay read the report of its trials at North Shore, near Liverpool, by Captain Vandeleur, Gunnery Inspector of the Royal Arsenal, Woolwich; and afterwards proceeded to lay before the meeting the result of his experiments with regard to the crystallisation of large masses of iron by long-continued beating, and maintained that, however iron may be crystallised by exposure to heat, or carelessly burnt, which was the same thing, its fibre might be restored by working either under the hammer or in the rolls. He was also of opinion that another reason why large forgings fail, was the uneven contraction of the heated iron.

On an Instrument for determining the Value of Intermittent, or Alternating, Electric Currents, for Telegraphic Purposes. By WILDMAN WHITEHOUSE.

After showing the impossibility of ascertaining by the galvanometer of the usual form, the force of any current whose duration is not sufficient to admit of the needle assuming a position of rest, and more particularly with reference to currents of alternating polarities, such as the usual form of magneto-electric currents, the author proposed to avail himself of the force of magnetic attraction instead of the deflection of the needle; and this force, he said, "was, till we approach the point of magnetic saturation of the iron, strictly proportioned to the energy of the current under examination."

"The force of the magnetic attraction or 'lift,' thus obtained, is made to manifest itself upon the piece of soft iron which, fixed to a lever, has been carefully balanced on knife-edges or agate-points, and loaded to any given weight. The current either lifts, or does not lift, the given weight; and here is the test of what the author proposes to call its *value* in telegraphy.

"So delicate is this test, that I have been able," he says, "to determine accurately the 'value,' as it may be termed, of a current too feeble in its energy, too brief in its duration, to give the slightest indication of its presence on one of the most sensitive 'detectors' usually employed in critical telegraphic observations.

"Yet, accurate as this instrument is in the determination of the value of feeble currents, I find that it admits of a range far exceeding anything that could have been anticipated. I have weighed with accuracy a current whose force is represented by seven-tenths of a grain; and, on the other hand, currents with a wide range of quantity and intensity, and of varying amounts of force up to no less than six hundred thousand grains, have been weighed with a very fairly demonstrable degree of accuracy upon the little instrument before you, which I now proceed further to describe in detail." After showing the instrument, which is somewhat similar in appearance to a delicate steelyard, bearing a piece of soft iron at its shorter end, and supported on knife-edges resting on polished steel or agate bearings, he says: "The further end of the lever rests between two stops, and the arms bear the relation to each other of one and five—experiment having proved that this proportion was more convenient than one and ten, while the adoption of a double weight gives still the advantage of decimal calculation in the results: thus there are four weights, actually 2, 20, 200, and 2000 grains, but representing severally, 1, 10, 100, and 1000 grains; these, in the various positions which they may assume on the graduated arm of the lever, will represent anything from unity up to 10,000 grains.

"In order to weigh upon the same instrument currents whose force is represented by higher figures than these, I have been obliged to have recourse to an expedient which will readily suggest itself to the mind of any one accustomed to the laws and use of electro-magnets. I have provided other bearings for the lever, which withdraw the keeper to such a distance from the poles, that the attraction of the electro-magnet has only one hundredth part of the power over it which it previously had.

"Every result now obtained simply requires the addition of two cyphers to it; thus, the 1 grain weight becomes 100, 10 becomes 1000; 100 becomes 10,000; and 1000, 100,000. In this way we avoid injuring the instrument by the sudden and

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violent concussion which the lift of the strong current would produce upon the bearings, while we guard against error which would arise from yielding of the parts.

"Great care is required in the original construction and adjustment of these bearings to each other; accuracy once having been obtained as an actual practical result, it is easily verified at any time, and if deranged is readily re-adjusted.

"In the use of this instrument with interrupted currents, being repetitions of the same polarity, an amount of error arises from the steady increase up to a certain point of residual magnetism in the iron; this is easily weighed out at the end of the experiment, and deducted from the previous result. In its use with alternating currents, on the other hand, residual magnetism need not be regarded, inasmuch as no error can continue after the first few beats (unless by a sudden change from very strong to very feeble currents), because each current must neutralise the residual magnetism left by its predecessor, before it can itself polarise the iron and produce the lift.

"Nothing also is easier in preparation for delicate experiments, than to de-magnetise it by rapid alternations, reversing the polarity, and then gradually diminishing the strength of the currents, till at last you will find the iron without one single grain of residual magnetism left in it."

Mr. Whitehouse then, to illustrate its use, enumerated several of the purposes to which he had already applied it.

Among these were, first, an analysis of the relative value of the secondary currents from various induction rods of different construction and size, as well as from the same coil excited by various amounts of battery power. Second, a comparison of results obtained from the use of a quantity-battery and induction coils, with those obtained from the use of the same amount of positive metal divided into a great number of smaller elements in the form of a long series, or intensity-battery. The results of this inquiry, when thrown into a tabular form, together with the amount of hydrogen evolved per cell in each case, will present a subject of high interest, both in a theoretical and practical point of view. Third: Conjoined with the use of a seconds' pendulum and recording instrument to examine the question of duration of various magneto-electric currents, and not only the whole duration of the current but the duration of its several parts, *i. e.*, of its maximum and minimum and of every intermediate degree of force; this is done by means of a battery recording on paper by electro-chemical decomposition, the contact for which is given by the lever at the instant of the lift. Fourth: Ascertaining the value of magneto-electric currents as tried at various distances, say 40 to 320 miles from the instrument generating them, and comparing them with the same kind on short circuits. "Of the importance of these last results," he said, "I need say no more than that it will enable me (by repeated observations) to ascertain with certainty and minute accuracy the loss due to the combined effect of resistance, induction, and defective insulation in each length of wire, and to compare with each other, under similar circumstances, results obtained at different distances.

"The last, and not the least, important series of observations in which this little instrument has rendered me good service has been in the working out some of the laws relating to induction in submarine circuits.

"To illustrate this by one example: In experimenting recently upon 498 miles of very perfectly insulated submarine cable wire, in which the phenomena of induction and retardation of 'charge' and 'discharge,' (as originally described by Faraday), were exhibited in a most marked manner. The current employed was that from an ordinary sand battery of 288 cells, one pole of which was in connection with earth.

"This current, on short circuit, was capable of sustaining, as its maximum weight, 18,000 grains. The instrument was placed in the long circuit, and so arranged as to admit of weighing first the continuous run of the current into the wire to produce the 'charge' (circuit being open at the other end of the wire), and next the 'discharge' to earth, produced by breaking the circuit of the battery and instantly making a closed circuit from the line wire through the instrument to earth.

"I need hardly say that my surprise was indeed great when I found that a continuous run into the wire of not more than 4300 grains was followed by a lift of no less than 60,000 grains at the instant of my discharging the wire to earth; so strikingly cumulative is the tendency of this gigantic Leyden jar. This experiment was repeated many times with perfect uniformity in the results. It was then varied by adopting an arrangement admitting of the wire being charged or discharged from both ends simultaneously, instead of at one end only. There was then a continuous run of 5000 grains, followed by a *lift* of 96,000 grains at the instant of discharging the wire to earth; thus realising as a return more than five times the amount which the battery gave as its maximum on short circuit. The only indications observable on a very sensitive needle (detector) in circuit were that the continuous run showed 76° in the first, and 77° in the second experiment, and that it was most violently thrown in the opposite direction at the moment of discharge to earth and very soon returned again to 0°.

"Further instances need hardly be adduced to illustrate the practical utility of such an instrument to those engaged in electro-telegraphic researches. To complete, however, its usefulness, and to render the results obtained by one observer strictly comparable with those of other labourers in the same field, and even with his own at a later period, it is necessary to have one common standard of comparison, to which all instruments so made may be adjusted at first, and with which they may, at any subsequent time, be compared. With this view, I have determined to set aside for this special use the most accurately finished and perfect instrument I can obtain, with which I shall be most happy at all times to compare those of any of my fellow-labourers in the field."

The author proposes to name it a "Magneto-Electrometer," from its special adaptation to the measurement of magneto-electric currents, while the terms "Galvanometer," "Voltameter," and "Electrometer," sufficiently indicate for those instruments, their connexion with other forms of electricity.

Illustrations were then given of the practical working of the instrument. A current of very feeble force from a small magneto-electric instrument was found to weigh about four grains; it was sufficient to work perfectly a telegraphic receiving instrument, which, together with the magneto-electrometer and a beautifully-sensitive detector, were included in the same circuit. The detector demonstrated the existence of a current, but gave most uncertain indications as to its amount, its movements having a greater range when the alternating currents were slow but feeble, than with currents of considerably greater strength, which followed one another rather more rapidly.

A pair of induction-coils were then used, excited by six small cells of Smee's battery; the current from these was found to weigh 27,000 grains without the keepers; the addition of one keeper augmented it to 43,000, and the second keeper to 47,500. These weights were taken upon the upper bearings, and illustrated most perfectly the capabilities of the instrument.

The most striking features of this instrument appeared to be the very great range of which it admits (viz.: from units up to several hundred thousand grains), together with the definiteness and accuracy of the results, even the extremes of the register being strictly comparable with each other; and, lastly, unlike the degrees upon the galvanometer, these grains of force are units of real "value" and of practical utility, as was shown by the fact that the telegraphic instrument in circuit was worked perfectly by a current of four grains.

"*The Law of the Squares*"—*is it Applicable, or no, to the Transmission of Signals in Submarine Circuits?* By WILDMAN WHITEHOUSE.

Referring to the proceedings of this section last year at Glasgow, the author quoted Professor W. Thomson's paper on this subject, where he stated "that a part of the theory communicated by himself to the Royal Society last May, and published in the proceedings, shows that a wire of six times the length of the Varna and Balaklava wire, if of the same lateral dimensions, would give thirty-six times the retardation, and thirty-six times the slowness of action. If the distinctness of utterance and rapidity of action, practicable with the Varna and Balaklava wire, are only such as not to be inconvenient, it would be necessary to have a wire of six times the diameter, or better, thirty-six wires of the same dimensions, or a larger number of smaller wires twisted together, under a gutta-percha covering, to give tolerably convenient action by a submarine cable of six times the length."

Mr. Whitehouse then stated that circumstances had enabled him to make very recently a long series of experiments upon this point, the result of which he proposed to lay before the section, adding that an opportunity still existed for repeating these

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experiments upon a portion of cable to which he could obtain access, and that he was ready to show them before a committee of this section in London if the important nature of the subject should seem to render such a course desirable.

Although the subject of submarine telegraphy had many points of the highest importance requiring investigation, and to the consideration of which he had been devoting himself, the author proposed to confine his remarks on this occasion to the one point indicated in the title—inasmuch as a decision of that one, either favourably or otherwise, would have on the one hand the effect of putting a very narrow limit to our progress in telegraphy, or, on the other, of leaving it the most ample scope. He drew a distinction between the mere transmission of a current across the Atlantic (the possibility of which he supposed everybody must admit), and the effectual working of a telegraph at a speed sufficient for "commercial success," and we gathered from his remarks that there were those ready to embark in the undertaking as soon as the possibility of "commercial success" was demonstrated. He then gave a description of the apparatus employed in his researches, of the manner in which the experiments were conducted, and lastly of the results obtained. The wires upon which the experiments were made were copper of No. 16 guage, very perfectly insulated with gutta-percha, and spun into two cables containing three wires each of equal length (83 miles), covered with iron wires, and coiled in a large tank in full contact with moist earth, but not submerged: the two cables were subsequently joined together, making a length of 166 miles of cable, containing three wires. In addition to this, in some of the latest experiments he had also the advantage of another length of cable, giving with the above an aggregate of 1020 miles.

The instruments, one of which was exhibited, seemed to be of great delicacy, capable of the utmost nicety of adjustment, and particularly free from sources of error. The records of the amount of retardation were all made automatically by electro-chemical decomposition on chemically prepared paper. The observations of different distances recorded themselves upon the same slip of paper—thus 0·83, and 249 miles were imprinted upon one paper; 0·83, 498 upon another slip; 0·249, 498 upon another; 0·535, 1020 upon another; thus, by the comparison of the several simultaneous records on each slip, as well as by the comparison of one slip with another, the author has been enabled to show most convincingly that the Law of the Squares is not the law which governs the transmission of signals in submarine circuits. The author showed next, by reference to published experiments of Faraday and Wheatstone, ("Philosophical Magazine," July 1855), that the effect of the iron covering with which the cable was surrounded, was, electrically speaking, identical with that which would have resulted from submerging the wire, and that the results of the experiments could not on that point be deemed otherwise than reliable. He next alluded to the objection raised by Professor Thomson against experiments in "multiple" cables. Faraday, he said, had experimented upon wires laid in close juxta-position, with reliable results (See "Experimental Researches," vol. 3, page 575); but, in addition to this, our author proposed to himself to answer this objection by an appeal to direct experiments. To decide the question, he first weighed the amount of induction produced in one wire during the use of interrupted or alternating currents in an adjacent wire. A current of eighteen thousand grains thrown into one produced in a length of 166 miles, a current of one grain and a-half by induction in the adjacent and parallel wire; in round numbers, one grain in 10,000,—so slight an amount of interference, in fact, that it may be practically disregarded in this investigation. Indeed, it was found impossible to produce any appreciable difference with reference to the retardation by varying the arrangement of the wires, so that at one time they should carry like currents, at another time unlike, as long as the earth remained part of the circuit. But the author was not without the testimony of most competent persons as additional evidence upon this point. Lieutenant-Col. Biddulph, director of the Black Sea Telegraph—the very line to which Professor Thomson refers—happening to be in England at the time of these researches, went through a series of experiments with our author, and gave as his opinion, "that the phenomena of induction and retardation were as marked, and that there was fully as much, if not more, embarrassment of instruments in these 498 miles of cable as he had met with in the Black Sea line." We may take it as proved, therefore, that experiments on such a cable, fairly and continuously conducted, may be regarded as real practical tests, and the results obtained as a fair sample of what will ultimately be found to hold good practically in lines laid out *in extenso*. Attention was then called to a table showing the amount of retardation observed at various distances, and under as nearly similar conditions as was possible to obtain. In this are embodied the results of far more labour than meets the eye. At the head of each column is stated the number of observations upon which the result given was computed, every observation being rejected on which there could fall a suspicion of carelessness, inaccuracy, or uncertainty as to the precise conditions; and on the other hand, every one which was retained being carefully measured to the 100th part of a second.

This table is subject to correction for variation in the state of the battery employed just as barometrical observations are subject to correction for temperature. "Of this variation, as a source of error," said our author, "I am quite aware, but I am not yet in possession of facts enough to supply me with the exact amount of correction required. I prefer, therefore, to let the results stand without correction. Now it needs not long examination of this table to find that we have the retardation following an increasing ratio, that increase being very little beyond the simple arithmetical ratio.

"I am quite prepared to admit the possibility of an amount of error having crept in these figures in spite of all precautions. Indeed, I have, on that account, been anxious to multiply observations, in order to obtain trust-worthy results; but I cannot admit the possibility of error having accumulated to such an extent as to entirely overlay and conceal the operation of the law of the squares, if, in reality, that law had any bearing on the results. Taking 83 miles as our unit of distance, we have a series of 1, 2, 3, 6, and 12. Taking 166 miles as our unit, we have then a series of 1, 3, and 6. Taking 249 miles, we have still a series of 1, 2, and 4, in very long distances. Yet, even under these circumstances, and with these facilities, I cannot find a trace of the operation of that law."

Table of Retardation observed at Various Distances.

Voltaic Current — Time stated in parts of a second.

Mean of 550 observations.	Mean of 110 observations.	Mean of 1840 observations.	Mean of 1960 observations.	Mean of 120 simultaneous observations.
83 miles ...	166 miles ...	249 miles ...	498 miles ...	535 miles ... 1020 miles
·08	·14	·36	·79	·74 1·42

The author then examined the law of the squares, as shown by the value of a current taken in submarine or subterranean wires, at different distances from the generator thereof.

Magneto-electric currents were weighed at Liverpool, which had travelled respectively 40, 120, 240, and 320 miles — from Manchester, Birmingham, London, and Belfast. The results did not confirm the laws of the squares, and the most distant came out with less loss than a comparison of the shorter lengths had led him to anticipate. Another result was even more striking. The voltaic current from a battery of very moderate power, weighed at a distance of 498 miles, in the cable before mentioned, 250 grains on its exit from the wire to earth. Divide the cable into six lengths, and, in accordance with the law of the squares, at some part of the first length this current ought to be found weighing 36 times 250 = 9000 grains. This is nearly half as much again as the current actually did weigh at 83 miles, and nearly 1500 grains more than the same current (by observations both at the beginning and end of the experiment) gave as its maximum lift on short circuit. These observations, by weight, though not possessing, if taken by themselves, the full force which would be due to them had the subject of loss by travelling, and the ratio thereof, been fairly worked out, are yet strongly corroborative of the general results.

"Intimately connected with the consideration of this subject," said our author, "is another which is so closely related to it as to be almost a necessary and integral part thereof. I mean the question of the *size of the conducting wire*. I venture to allude to it now (even though from its importance a subject of special research with me at this moment, and my series of experiments on this point, still in progress and far from complete), because it may be regarded as an appeal to another court for a decision upon the same question put in a different form. The number of wires in the cable enabled me to determine the relative degrees of retardation observable when using a single, double, or treble-sized conductor of the same length in each instance—viz., 166 miles. I had thus to a limited degree the opportunity of testing the application of this law as enunciated by Professor W. Thom-

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son last year, with reference to the size of conductor necessary, to which I have already alluded. The results, far from confirming the law, are strikingly opposed to it. The fact of trebling the size of the conductor augmented the amount of retardation so as to nearly double that observed in the single wire. I give the actual figures obtained as the mean of one series of thirty-two observations on the point:

Amount of retardation taken at 166 miles—

Voltaic current—Time stated in parts of a second.

Size of conductor.	Mean of 32 observations.
Single	·15
Double	·20
Treble	·17

Velocity as deduced from the foregoing—

Single wire and earth	1100	miles per second.
Double wire and earth	830	„ „
Treble wire and earth	614	„ „

These observations were taken again and again with extreme care, were repeated on several days, and with uniformly corresponding results."

The author then stated that the most searching and most practical test, in fact the *experimentum crucis*, would be found in the limit of the rapidity and distinctness of utterance attainable at different distances. He laid before the section records taken at 498 and 1020 miles. These being taken by the same instrument, and under like conditions, may be regarded as perfectly reliable for comparison with each other, though from being taken with the magneto-electric, instead of voltaic current, and recorded by a new form of instrument, they are not comparable with results obtained by any of the ordinary form of telegraphic instrument. Three hundred and fifty was the highest number of distinct signals recorded in the minute through 498 miles, and two hundred and seventy through 1020 miles, the former being at the rate of nearly six in the second, the latter four and a half in the second. These figures bear no relation to the squares of the distance—they are even far beyond the simple arithmetical ratio.

"Now, if the law of the squares be held good in its application to submarine circuits, and if the deduction as to the necessary size of the wire based upon that law can be proved to be valid also, we are driven to the inevitable conclusion that submarine cables of certain length, to be successful, must be constructed in accordance with these principles; and what does this involve? In the case of the transatlantic line, whose estimated length will be no less than 2500 miles, it would necessitate the use, for a single conducting wire only, of a cable so large and ponderous as that probably no ship, except Scott Russell's leviathan, could carry it; so unweildy in the manufacture, that its perfect insulation would be a matter almost of practical impossibility; and so expensive, from the amount of materials employed, and the very laborious and critical nature of the processes required in making and laying it out, that the thing would be abandoned as being practically and commercially impossible. It has been calculated by one intimately connected with this branch of manufacture, and to whom the art of submarine telegraphy owes much of its success, that the first cost of the copper wire alone for a single conductor of such a size would exceed the entire cost of an electric cable containing three circuits of the ordinary guage; while the amount of money and time involved in making and insulating one of the large size perfectly, is, he says, impossible to arrive at.

"If, on the other hand, the law of the squares be proved to be inapplicable to submarine wires, whether with reference to the amount of retardation observable in them, the rapidity of utterance to be obtained, or the size of the conductor required for the purpose, then we may shortly expect to see a cable not much exceeding one ton per mile, containing three, four, or five conductors, stretched from shore to shore, and uniting us to our transatlantic brethren, at an expense of less than one-fourth that of the large one above mentioned, able to carry from four to five times the number of messages, and therefore yielding about twenty times as much return in proportion to the outlay. And what, it may be asked, is the general conclusion to be drawn as the result of this investigation of the law of the squares applied to submarine circuits? In all honesty, I am bound to answer, that I believe nature knows no such application of that law; and I can only regard it as a fiction of the schools, a forced and violent adaptation of a principle in physics, good and true under other circumstances, but misapplied here."

WESTMINSTER BRIDGE.

According to the reported evidence before the Parliamentary committee, Messrs. Rendel and Simpson and Mr. R. Stephenson "condemn the principle upon which the piers of this proposed bridge are being constructed, as not being of a permanent character, and being likely to decay and subside." But supposing the principle to be sound, cofferdams would be necessary to secure its only reliance—"*faultless execution*," totally impossible without them. And if cofferdams be adopted, why not get rid of the doubtful, or at least "less permanent and secure," contrivances, however ingenious, to obviate their necessity?

So far as to new work. The removal of the old bridge and the roots of its piers might be a very questionable proceeding without drying around them, and this would be still more required to examine and to equalise the foundations of the new work where interfered with by the old; without this, if it were even possible to execute the second part of the bridge, the mixed footings could not but result in settlements and disasters, if not the downfall of that part of the structure; moreover, with the hidden obstructions from the old works, the round metal piles could not be driven with the accuracy required.

The embankment of the river being not much spoken of when the designs were made out, though now as certain as it was then improbable, it is not to be wondered at that more consideration was not given to the consequent deepening or alteration of the channel. A change is therefore absolutely necessary to meet the altered circumstances of extra depth, certain to follow; the piers would be "weakened by the increase of their unsupported height," and by the decrease "of the depth and solidity of the material" through which their pile-support should have been driven.

It is true, the Parliamentary committee report that they "are satisfied that the proposed piers are of strength amply sufficient to bear the weight proposed to be placed upon them;" but they negative this favourable opinion almost in the next line, by the qualification, "that the piers will *be secure as long as the iron casting remains sound*," and that the iron casting can be replaced whenever it may decay or be destroyed, although the stability of the piers, by their own showing, is dependent on it. If the iron casing or casting should be destroyed at the commencement of a severe winter, when and how could it be replaced?—and how long would the piers be safe without it, if only secure "as long as the iron casting remains sound"? The bond of the wrought-iron perishable tie-bolts must be admitted to be necessary, or they would not be introduced. What reliance could be placed on them, even if they should not be decayed, when the iron casting they are to connect becomes "decayed or destroyed"? What then would prevent the granite slabs on edge and concrete within it splitting and spreading out from the pressure on them?

Taking into consideration all these facts and circumstances, the conclusion must be the same as that arrived at by the committee, viz.—"That such a mode of construction is less permanent and secure than granite piers founded deep into the London clay by means of cofferdams."

There is no evil out of which good may not arise, and the idea of abandoning the site of the present Westminster-bridge altogether has very much to recommend it. Any bridge raised to the height over the water required for the navigation of the river Thames, and so near to the Houses of Parliament, must have the effect of burying that lowly-placed palatial structure.

The most satisfactory arrangement for the public is simply as suggested. Let the present bridge be secured for temporary duty, and let a new bridge be built at Lambeth (Horseferry) on Mr. Page's design, but with granite piers and abutments; also a precisely similar bridge be built below the present one, where, it is said, a desirable site can be found. The most obvious site is between the Board of Control and the rise of Richmond-terrace, opening out to Parliament-street; and widening and opening Charles-street at least until the straight line from Regent-street, and a continuation of the Bird-cage-walk, would meet it; for there can be no doubt but that the concentration of the public offices there and thereabout, as contemplated, and the metropolitan convenience, will require, sooner or later, the opening of the proposed thoroughfare from Waterloo-place, which, without touching the Parade, or in the slightest degree injuring St. James's Park, could be made one of the finest boulevards to be met with in any city, and it would be as convenient as it would be beautiful.

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The propriety of removing the York column to a more fitting site would then be demonstrated, for even now it may be observed it completely shuts and shortens the vista from Waterloo-place that otherwise would be terminated by the Victoria tower and the Palace of Westminster. To make amends for the removal of the column, the new road from Waterloo-place might be called "the York-road;" and if no other, a fine site would offer for the rebuilding of it at the east end of St. James's-park, directly opposite the approach from the new Westminster-bridge, but not to interrupt the line of the vista proposed from Regent-street.

A more elegant and picturesque site for the new bridge would be at the end of Richmond-terrace, removing the Irish Office and the block of houses between Downing and Fludyer streets quite through to the park; but it would be neither so convenient nor so profitable to the public as from Parliament-street to the river. At neither side would there be *frontage* to *dispose* of, and the present occupants might gladly dispense with the bridge and approaches; whereas, behind the terrace part of the ground is not built on, and the block between Derby-street and the passage to the Architectural Museum removed would at once give frontage and a spacious opening.

At the Surrey side, it would be a real benefit to open a new street straight from this proposed bridge quite through to the Waterloo-road; and the turn in the Westminster-bridge-road, west of the railway crossing, would admit its very perfect junction with the direct approach to the new bridge.

Lastly, the connection of the two bridges, Lambeth and Westminster, with handsome quays and balustraded parapets at both sides of the river in front of the Houses of Parliament, would be a first and a very legitimate step towards the entire reform of the Thames, so long talked of while so little has really been effected.

ON WATER METERS.

SIR,—Your August number contains an article describing Mr Kennedy's Water Meter, and embodying a report, by Mr. G. W. Stevenson, of Halifax, on the comparative results obtained by him in testing Taylor's, Siemens', and Kennedy's meters.

Being interested in one of the meters referred to, which bears my name, I shall refrain from criticism of Kennedy's meter; but I feel called upon to trouble you with a few remarks regarding Mr. Stevenson's experiments, with a view to caution your readers and the public against hasty conclusions, and to elicit truth by inviting to farther and more careful inquiry.

In order to avoid misapprehension, I beg to state distinctly that I do not doubt Mr. Stevenson's scrupularity in stating the results of his experiments such as he found them; but what I object to is, his mode of conducting the experiments, which affords no security against error, which leads to erroneous conclusions respecting the capabilities of each meter, and also leaves untouched the two chief desiderata of a water meter, —those, namely, of durability and facility of application.

1. *As to the accuracy of measurement.*

Mr. Stevenson filled a gallon measure one hundred times through each meter, and found that in the first experiment Siemens' meter went 5 per cent. too fast; in the second, 1 per cent. too slow, and in the third correctly; whereas Kennedy's meter was always correct within 1 per cent. It would appear from this, that Siemens' meter varied as much as 6 per cent. between two consecutive experiments, which I believe, from *long experience* to be *quite impossible*. But it is not difficult to account for an error of a few per cent. by Mr. Stevenson's primitive mode of measuring the water as it passed through the meter, and in reading so small a quantity as 100 gallons upon a dial indicating 1000 gallons by one single turn. I maintain that the proper way of trying the accuracy of a meter is, to pass through it a quantity not less than 1000 gallons, and to run the same into a cistern holding that quantity between marks ascertained by exact calculation, or rather by weight.

2. *As to relative quantity delivered.*

Mr. Stevenson has taken for his standard of comparison the diameter of the unions attached to each meter, whereas the proper standard would have been similar quantities stated to be delivered according to the published prospectuses.

Experience has induced Messrs. Guest and Chrimes, the manufacturers of Siemens' meters, to limit the power of delivery to what is practically required, by restricting the passage through the meter. Such restriction will not impede the flow of water through a long range of pipes (it is well known to engineers practically acquainted with water works, that a sluice in a range of pipes may be more than half shut without impeding the flow of water, the reason being that the vis-inertia the water acquires in passing the restriction is spent again in the succeeding pipe in urging the water column forward), but is intended to diminish the delivery in cases where the meter is placed at the extremity of a pipe. High-pressure meters are generally applied below ground at the entrance of a branch pipe into an establishment; and in order to test the real capabilities of such a meter, it ought to be placed as nearly as possible under these normal conditions, which was not the case in Mr. Stevenson's experiments. But adopting, for the sake of argument, Mr. Stevenson's results, he is evidently mistaken when he says that "the price also (of Kennedy's meter) is really less *pro rata* than that asked for either Taylor's or Siemens'. Taylor's being 5*l.* per inch, Siemens' a little more, and Kennedy's about eight guineas." The report goes on: "The capacity for supply, however, ought to regulate the price, &c." Now, if Mr, Stevenson would refer to Messrs. Guest and Chrimes' list of prices, he would find that their meter with 1½-inch inlet, will deliver just twice the quantity of their 1-inch, and consequently the same quantity as Mr. Kennedy's with 1-inch inlet. The price of Siemens' meter with 1½-inch inlet is, however, only 3*l.* 6*s.*, or slightly less than Kennedy's of the same power of delivery, under the unfavourable circumstances of the experiment. No account is taken of the cost of transport and erection, which in the case of Kennedy's meter exceeds considerably that of Siemens' meter, owing to its far greater bulk and weight.

3. *As to relative loss of pressure sustained by the passage of water through the meter.*

In Kennedy's meter the water has to move a piston and to pass through several short bends, whereas in Siemens' it has always a free passage through curvilinear channels, that represent, together with the inlet, two bends. It is, therefore, not well possible that Siemens' meter should impede the water more than Kennedy's, provided the quantity of water delivered does not exceed the limits assigned to it.

Having now referred to the three points of Mr. Stevenson's investigation, I have to suggest a fourth point, which far exceeds the others in importance, namely:

4. *As to durability.*

It is a comparatively easy problem to produce a meter that shall give satisfactory results in a laboratory experiment. Indeed the first meter the writer ever made, in 1851, left little to be desired in this respect, and was highly approved by a committee of the Manchester Corporation Waterworks. All the difficulty, however was to come, and consisted in producing an instrument from which more is required than ordinary mechanism will stand. A high-pressure water meter is generally placed below ground, and is required to work for several years without needing any attention whatever. Unlike the gas meter, it has to work under pressure ranging from a few inches to 300 feet of water column; it has to resist great concussions in the water, and to be unaffected by impurities—such as sand, shells, and vegetable matter—in the water, nor by its calcareous deposits; combining with this extreme delicacy of action. It remains for Mr. Kennedy to prove that his piston, tumbler, and valve possess the quality of resisting permanently these agencies; but in order to judge of the relative merits of several meters, I should suggest to put the same in a trying situation, both as regards pressure and impurities (at the end of a low-level main for instance), to lock them up for six or twelve months, and then examine them as regards their accuracy of measurement and general state of conservation.

In conclusion, I may be allowed to state an interesting fact regarding Siemens' meters, namely, their accuracy (within 3 per cent.) and their durability being guaranteed by the manufacturers; all defective meters are returned to them, and the number so returned, during the last 14 months, has been 33 out of nearly 2000 meters in operation. The increasing demand for them does not bear out Mr. Kennedy's statement, that no satisfactory meter existed before his own was proposed.

W. SIEMENS.

London, 25th August, 1856.

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WATER WORKS. PUMPING ENGINES.

Fig. 1.
Side Elevation

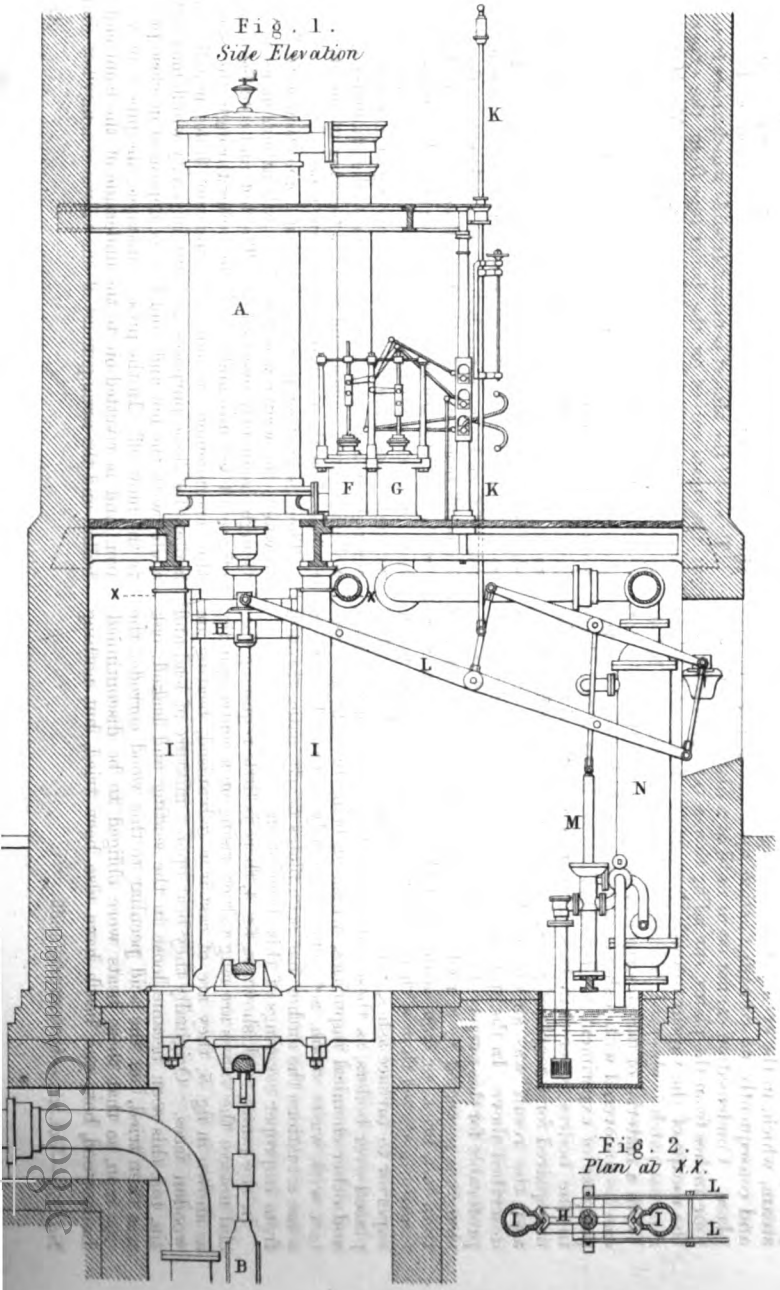


Fig. 2.
Plan at X X.

Fig. 3.

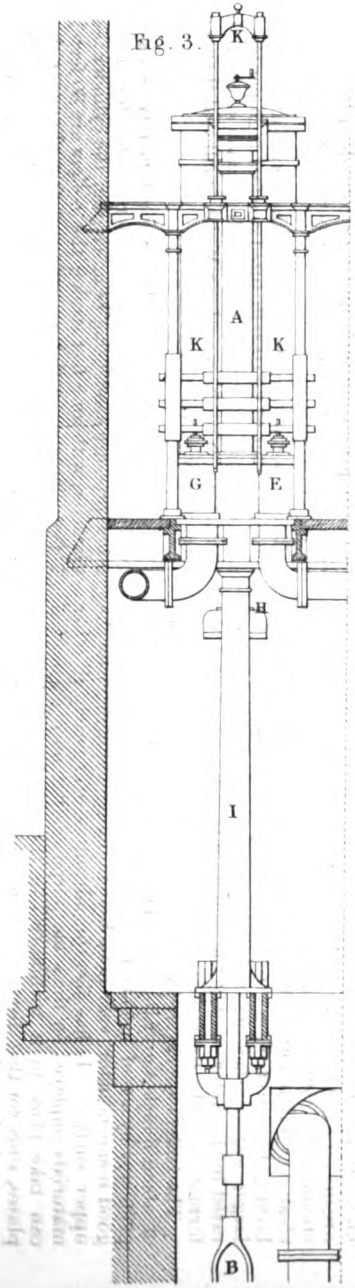
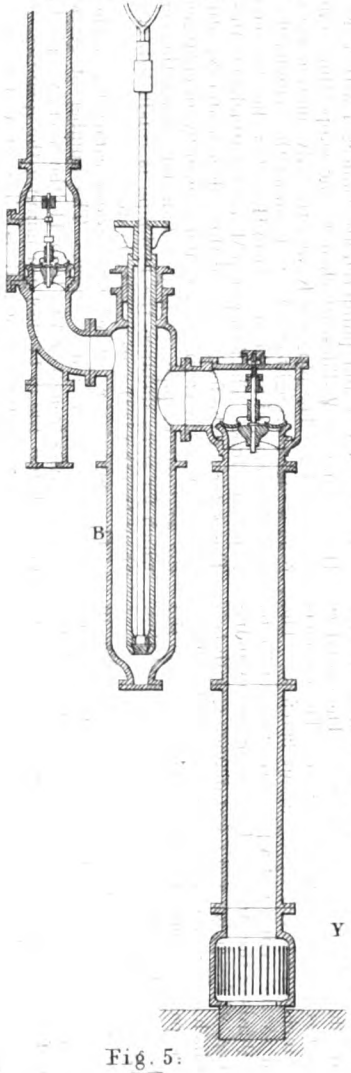


Fig. 4. *Section through Valves.*



Goldthorn Hill Pumping Engine.
Regulating Valve for Reservoirs.

Fig. 6.

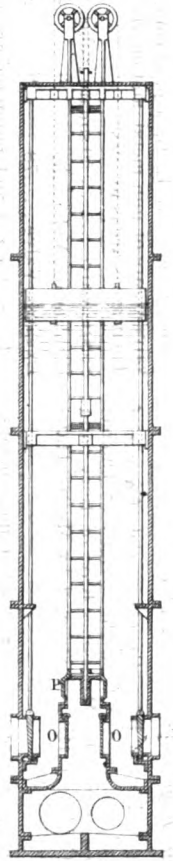


Fig. 7.

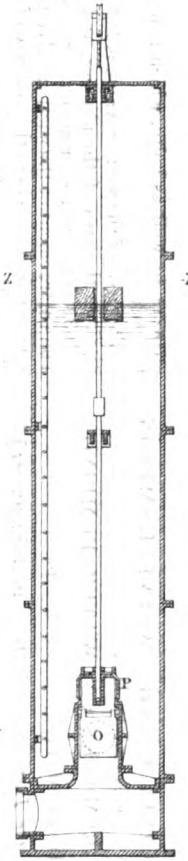


Fig. 5.
Detail of Delivery Pump Valves Valve.

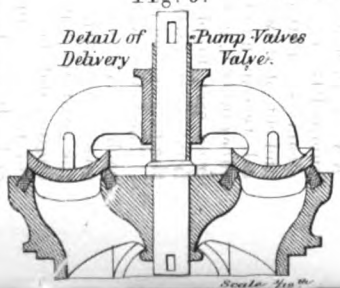


Fig. 8.
Plan at Y.Y.

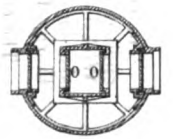


Fig. 9.
Plan at Z.Z.

Scale for Figs 1. 2. 3. 4. 6. 7. 8 & 9.

Inches 0 1 2 3 4 5 6 12 Feet

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PUMPING ENGINES OF THE WOLVERHAMPTON WATERWORKS, WITH SOME REMARKS ON WATER PUMPING.

By Henry Marten, Wolverhampton.

[*Paper read at the Institution of Mechanical Engineers.*]

(*With Engravings, Plate* XXVI.)

The engines described in the present paper consist of a pair of engines at Tettenhall, constructed from the designs of Thomas Wicksteed, C.E., and erected by Mr. James Kay, of Bury; and also an engine at Goldthorn Hill, constructed by Messrs. Hawthorn, of Newcastle-on-Tyne.

The engines at Tettenhall are single direct-action non-condensing engines, and are shown in detail in figs. 1 to 5. The cylinders AA, are each 36 inches diameter, 9 ft. 6 in. stroke. The plunger-pumps BB, are 13 inches diameter, lifting about 300 feet. The steam is admitted to the cylinder at a pressure of about 35 lb., and cut off at two-thirds of the stroke. The boilers are cylindrical, two in number, 26 feet long, and 6 feet diameter, with two tubes in each, 25½ inches diameter, and internal fires. The flame from each fireplace passes along the tube, thence round to the front again by the side of the boiler next to its tube, and then the two uniting pass along the bottom into the chimney.

The boilers were originally constructed with only one flue in each, of 3 ft. 9 in. diameter; but it was found that the steam space was much too small for the size of the cylinders, and that the great draught of steam from the boiler at each stroke of the engine, and the consequent irregularity of pressure, so deranged the tube as to cause a constant leakage at the angle-irons at each end. It has been found in practice that the two smaller tubes are in every respect preferable to the single one, as they allow more steam room, better heating surface, and afford convenience for cleaning all round under the bottom, and by permitting the water level to be nearer the centre of the boiler shell, they admit of a larger water surface for the delivery of the steam as it is generated in the water, so that the ebullition is less violent, and the formation of the steam more rapid.

The boilers are covered with loam or moulding sand to a depth of about 6 inches over the top. This substance, which should be protected by a roof from being blown away, is found to be a very good non-conductor, very little heat radiating through it to the upper surface. It has also this advantage over nearly all other materials employed for the same purpose—that no condensation can take place in it within two or three inches of the boiler plates, since for that distance it forms a sand bath as hot as the steam, which, in the event of any leakage, blows through it dry, and consequently no corrosive action upon the plates can take place. Condensation cannot occur until at a distance of three or four inches from the plates, spreading thence very gradually with the escape of the vapour towards the surface of the sand, where a moist patch is observed, indicative of what is going on below. With a material of this description, any portion of the boiler top can be uncovered with a shovel and examined at once. For the purpose of experiment at Tettenhall, steam-blows at two places in the boilers covered in this manner were suffered to remain unrepaired for a couple of years, in order to try the effect fully, and the result was an entire absence of corrosive action, as described above. In the opinion of the writer, loam sand is much preferable for this purpose to any other material, provided always that it is protected by a roof or covering. It is much cheaper than felt, brick, or iron casing, and the plates are much more readily inspected than with the latter coverings. It is also much superior to furnace ashes, cinders, or riddlings, which are often placed over boilers, as these substances frequently contain acids and other chemical impurities, which on being brought into contact with waste steam, act very injuriously on wrought-iron; in some situations the author has seen plates nearly eaten through from improper coverings of this description.

In the pump work shown in fig. 4, there is little requiring special notice: the valves are ring valves, rising on a centre spindle, as shown in fig. 5; they are of cast-iron galvanised, beating on wooden faces. Originally they beat upon a mixture of lead and tin, but this soon became loose in the seating and leaked; oak was then tried, but the acid peculiar to this wood corroded the cast-iron, so that these beats were obliged to be discontinued. Lancewood, box, and beech have also been tried, but nothing answers so well as holly, which is now employed and continues to work well.

The area of the suction valve is 325 square inches, being about 2½ times the area of the plunger, and that of the delivery valve is 163 square inches, or about 1½ times the area of the plunger. The enlargement of the suction valve to this extent is found to be very serviceable where the velocity of the plunger is likely to be great in the ascending stroke.

The steam-valve E, the equilibrium-valve F, and the exhaust-valve G, are of gun metal, and on the double-beat construction. Their areas are as follows:

Steam Valve	50 square inches	= $\frac{1}{20}$th of area of cylinder.
Equilibrium Valve...	50 "	= $\frac{1}{20}$th of area of cylinder.
Exhaust Valve	78 "	= $\frac{1}{13}$th of area of cylinder.

The piston-rod and pump-rod are connected with a cross-head H, working on V slides attached to the supporting columns I, figs. 1 and 2. The plug-rod K, and the valve motion are worked from a slight wrought-iron beam L, under the cylinder floor, connected at one end to the cross-head H, and at the other end slung to parallel links. The feed-pump M, is also attached to this beam. The water for the feed is passed through a heater N, situated in the corner of the engine-house, and formed by an enlargement of the waste-steam pipe, 18 inches diameter, along the centre of which for some distance the feed-pipe is conducted, occupying about two-thirds the area of the heater.

The engine is regulated by a water cataract governed by a small ratchet-wheel and screw. The number of strokes per minute varies from 3 or 4 to 10 or 11, the average speed of the piston being 130 to 140 feet per minute; the quantity of water delivered per stroke is 56 gallons. The area of the plunger is 132 square inches, and the pressure on the bottom of the plunger is 130 lb. per square inch, making a total dead load of 17,160 lb., equal to a dead pressure of 16¾ lb. per square inch on the surface of the steam piston.

These engines are working for their kind at a fair duty, performing about 27,000,000 lb. lifted one foot high per minute, with a consumption of 1 cwt. of the small common slack of the neighbourhood. With Newcastle or Welsh small coal they would perform a duty of 36,000,000 lb.

The engine at Goldthorn Hill is given merely as a sample of a good useful pumping engine fitted for this neighbourhood. It is a low-pressure condensing beam-engine; the cylinder is 48 inches diameter, with an 8 feet stroke; the boilers are 30 feet long, and 7 feet diameter, with two tubes, 2 feet diameter beyond the furnace, and 2 feet by 2 ft. 4 in. at the fireplaces. The pressure of the steam is about 15 lb. per square inch. The boilers are clothed with felt and wood lagging, which was completed before the experiments with the loam sand had been tried.

To avoid the almost constant trouble which arises from leakage at the steam-valves on the boiler tops from the expansion and contraction of the main range of steam pipes, Mr. Hawthorn suggested that the main steam pipe should be conducted to the steam chest with a quadrant curve, so as to allow the two extremities connected with the steam nozzles a considerable amount of expansion and contraction, without a thrust sufficient to break any joints; and the writer has pleasure in stating that this arrangement has been completely successful, as there has not been the slightest leak either at the nozzles or steam chest. This arrangement is useful and efficient where there is one steam pipe leading off from between two boilers; where however the steam pipe leads off from one side, or where there is a range of more than two boilers, it is not applicable; and in these latter cases the writer has found no expansion joint so simple and effective as the wrought-iron diaphragm joint, consisting of a couple of circular wrought-iron plates, about 2½ times the diameter of the pipe, bellied about 3 inches, and rivetted together at the outer rim and to flanges on the main range of steam-pipe.

There is another point of detail in connection with the boilers to which the writer would wish to call attention, as it is useful though frequently overlooked. The hot and cold feed and blow off are all led into and out of the boiler through the same pipe; this arrangement avoids the numerous holes usually cut into boilers for these purposes, and any impurity which may enter the boiler with the hot and cold feed is deposited in close proximity to the blow off. In the present instance, the pipe is of wrought-iron, and is rivetted on to the underside of the front end of the boiler, and the arrangement of the valves is somewhat similar to

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those of a bath, where the hot, cold, and outlet valves all take off the same pipe.

It is also important that the feed should enter the coldest portion of a boiler, which from the action of the currents in those with internal flues is just under the fire-grate. When attention is not bestowed on this point, it frequently happens that seams and rivets leak from the sudden changes of temperature to which they are liable.

The boilers are flat ended, and have no stays, but there are three stout T irons rivetted on to the flat plates forming the ends, so as to stiffen them against the pressure. This remark applies also to the boilers at Tettenhall, which are flat ended, with T irons of the same description, working under the pressure of 35 lb. per square inch.

The writer's experience has led him to the conclusion, that, as a general rule and as far as circumstances will possibly permit, all boilers should be so constructed as to require no artificial support from stays; these tend to pull a boiler out of shape, loosen rivets, and are difficult effectually to fasten or repair; flaws are not readily detected in them, and often when their services are most required they give way from hidden corrosion, or else they strain the boiler so as seriously to damage it, if not fixed exactly in the direction of the line of tension.

The pumps at Goldthorn Hill draw the water from a well about 90 yards deep, and this depth is divided into two lifts of about 45 yards each; the diameter of the bottom working barrel is 14 inches, and that of the top 13½ inches. The valves are ring valves of gun metal, with gun metal seats. The average speed of the piston is 100 feet per minute, and the quantity of water raised per stroke is 48 gallons; the total dead pressure is 19,305 lb., equal to 130 lb. per square inch of area of the working barrel, and to 10½ lb. per square inch of surface of the piston. The steam is cut off at about half stroke; the steam, equilibrium, and exhaust valves are double-beat gun metal valves, and their sizes are as follows:

Steam valve	51 square inches	= $\frac{1}{36}$th of area of cylinder
Equilibrium valve...	51 „	= $\frac{1}{36}$th of area of cylinder
Exhaust valve	64 „	= $\frac{1}{28}$th of area of cylinder

The duty of the engine averages about 40,000,000 lb. raised 1 foot high per minute, with 1 cwt. of slack.

The Tettenhall engines deliver the water over a stand pipe, 180 feet high, whence it flows by its own gravitation to the town. The Goldthorn Hill engine delivers through an air vessel into two covered reservoirs lying near the engine, and raised about 20 feet above the top lift, and holding together 1,500,000 gallons. The reservoirs are arched over, and covered with two feet of soil, for the purpose of preventing vegetation and variation in the temperature of the water when exposed to the atmosphere, and this end is answered well, the water remaining for months of the same temperature, and perfectly clear and free from all vegetable or animal impurities. The reservoirs are prevented from being overfilled by a self-acting check valve, shown in figs. 6 to 9, which shuts against any supply beyond certain limits, so that the man working any pumping engine at a distance at once knows when his work is done. The valve is so arranged, that immediately the engine ceases to work, the supply to the town is maintained from the reservoirs through the flat valves O, underneath the self-acting stop valve P, which opens immediately there is any requirement for the supply to the town.

The object of a stand pipe is that the water may be always delivered from the engine over one uniform height, and consequently of one uniform pressure on the engine whatever varying circumstances may affect the delivery after the water has once passed the top of the stand pipe. Thus far it is useful, as the engine can always work under a defined pressure; but it is rather a costly and unsightly mode of attaining what in practice is found to be an unnecessary degree of perfection; since with a tithe of the cost all the necessary safety can be procured by pumping into an air vessel with a check valve on the delivery side; so that in case of a pipe bursting, or any sudden diminution of pressure taking place, it would be impossible for the engine "to go out of doors" at more than a certain regulated speed, by the partial contraction of the area of discharge through the self-acting movement of the check valve. Unless the stand pipes are carefully cased in winter, they are in great danger of being frozen, and very serious consequences have arisen from this cause. There is also a drawback with them, on account of the great weight of the column of water which has to be set in motion from a dead stand at each stroke of the engine.

The successful working of any pumping engine is dependent in a great degree upon the perfection of the pump valves. These must be so arranged as to deliver the water with ease and rapidity, and without any concussion in closing. As an illustration of the great practical importance of this question, it may be mentioned that when the Cornish pumping engine was first introduced for water works purposes on a large scale, it was on the point of being altogether abandoned on account of the imperfection of the pump valves. The valves were of a very large area, and on the old butterfly principle, and consequently, under the heavy pressure at which they were working, the concussion caused in shutting was so violent as to occasion serious alarm for the safety of the machinery and foundations. For some time the problem to be solved—to find a method of constructing a valve which should present a maximum area of discharge, with a minimum area of surface exposed to the concussion of the recoiling load at the termination of each stroke of the pump—presented difficulties that appeared insurmountable, until the idea of the application of a modification of the double-beat steam valve for the purpose happily occurred to Messrs. Harvey and West. These gentlemen adopted the expedient of making the double-beat valve self-acting, by slightly contracting the upper beat, as shown in fig. 10,

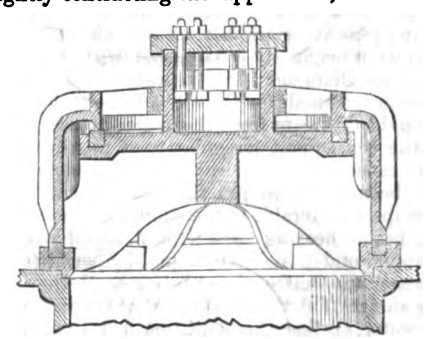

Fig. 10.

so as to allow the difference between the area of the outerside of the upper beat and the inside of the lower, as a surface upon which the pressure might act for opening and shutting the valve. This plan answered admirably; the valve in opening a very slight distance gave a large area of discharge, and the area upon which the recoiling column descended, being only the difference between the upper and lower areas, and not the entire area of discharge as in the old butterfly valve, formed a surface insufficient to cause any concussion. This valve also afforded under all circumstances a means of regulating the pressure tending to shut the valve, whatever might be the height of the column of water or the total pressure of the recoiling column, by adjusting the difference of area of the upper and lower beats inversely in proportion to the height of the column.

For ordinary purposes, that is to say for small lift pumps and colliery engines, the butterfly valve is very serviceable, as there are no expensive faces to be ground up, or liable to derangement from impurities or grit in the water, and they are easily and readily repaired on the spot. For a class of work one grade higher than ordinary, the writer has found no description of valve answer better than the double-beat ring valve, similar to those employed in the engines at Tettenhall and Goldthorn Hill, and shown in fig. 5. Large valves of this construction, of 16 to 20 inches diameter, answer well made of cast-iron with wooden beats. Smaller valves, of 8 to 15 inches diameter, are better of gun metal working face to face. Of the latter description the writer has had some at work for more than two years, under a pressure of 260 feet head, without any perceptible wear having occurred.

At the Hull Water Works, a new description of valve has been adopted in one of the pumps for some time, and is found to answer remarkably well. The valve is shown in figs. 11 and 12, and consists of a pyramid of circular seats, one above another, in each of which there are a number of small circular beats, about 2 inches diameter, into which a corresponding number of gutta-percha balls drop. The action of this valve, as will be seen from the figure, is very simple. It was invented by Mr. William Hosking, and inserted in the place of a double-beat valve. It is

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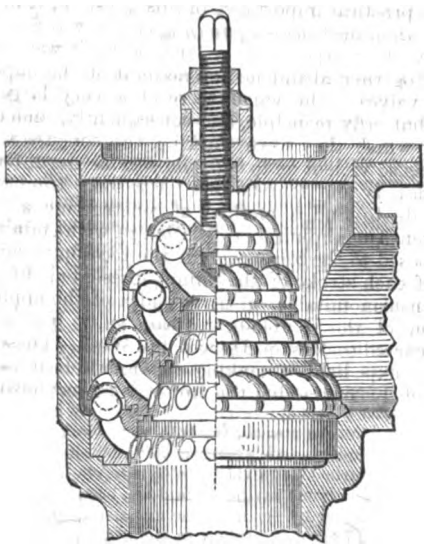
22 inches diameter, and works under a head of 160 feet, in connection with a plunger pump with a direct-acting steam cylinder. Immediately upon starting it was found that this valve lightened the burden of the engine about 1½ cwt., and it has since been working with great satisfaction for a considerable period.

Fig. 11.



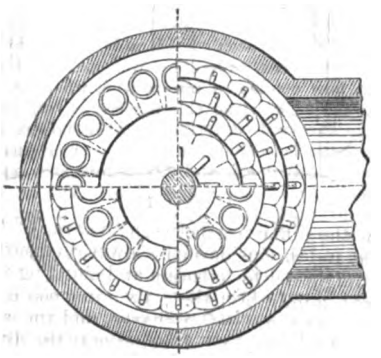


Fig. 12.

The advantages of this valve are more than are apparent at the first glance. In the first place, it is much safer than any other form of valve, as will be seen at once, supposing a piece of wood or other material should pass through the pump, as is not unfrequently the case. With the ordinary valve, if it should be caught on the beat, it would hold the whole valve open, and let the engine "come out" with a run, and possibly cause considerable damage; but with the small balls, a piece of wood so caught could prop open only 1 out of 56 balls, which is so small a per-centage of the whole opening, that it would merely enable the man in charge of the engine to perceive that there was a little amiss by an increase of leakage, but could cause no damage.

In the second place, the balls being nearly of the same specific gravity as the water, are just floated open the moment the current turns in their favour; whereas in all other valves, in addition to the column of water to be lifted, there is also the weight of the heavy metal valve to be opened and held suspended during each stroke. This was practically exemplified in the Hull case mentioned above, where a considerable load was at once removed from the engine on the application of the new valve. With larger valves this point becomes one of still greater importance, as they often weigh 5 or 6 cwt. each.

In the next place, whilst the area of discharge may be made fully equal to that of the plunger, the area exposed to concussive action in the closing of the valve is reduced to the smallest possible limits, being practically reduced to the impinging force upon one ball, the last one that shuts, that is $\frac{1}{56}$th only of the total area of beating face. This is owing to the circumstance that the balls do not all rise to the same height above their seats; and consequently, as the force of the current acts upon each individually, on the cessation of motion they shut in accordance with the height they have to fall, and a communication exists between the water on the upper and under side of the valve, until the absolute closing of the last ball. The result is, that although the difference in time between the falling of the various balls must be exceedingly minute, it is such as practically to prevent all concussion.

Lastly, the valves constructed on this plan are very readily repaired. It is only necessary to keep a few spare balls ready to be inserted in the place of any that may be occasionally damaged; and the old ones, on being warmed and recast in a mould kept for that purpose, are again as good as new.

Where it is proposed to work with a high pressure of steam, cut off so as to allow of a considerable expansion, the writer's experience has led him to prefer the beam to the direct-action engine. He has observed that as a rule direct-action engines working under a high initial pressure are apt to start off at a speed which strains and jars the whole of the machinery throughout. The speed attained by the piston as driven indoors at the beginning of the stroke is many times greater than the average velocity per minute, and consequently, unless all the parts are made extra strong in proportion, the bearings wear out with great rapidity, and the machinery is soon loose at every joint. In a beam engine, on the other hand, a very large proportion of the initial force is absorbed in overcoming the inertia of the heavy beam, which thus becomes a reservoir of surplus force in the earlier portion of the stroke to be given out during the later, and the result is that a comparatively steady velocity is maintained throughout the stroke, much to the advantage of the whole of the machinery; indeed it is only with this adjunct that expansion can be carried safely to a very high degree. The beam in fact is a reciprocating fly wheel, and is attended with precisely the same action and the same beneficial results. The writer is acquainted with a case of two large expansive engines of nearly the same size, working near together, of which one has an open net-work beam of about 30 tons, and the other a heavy strong beam of 45 tons weight. The difference in the working of the two engines is very perceptible, and nearly 5,000,000 lb. duty in favour of the heavy beam, in the steadiness and smoothness of the motion. In many cases where a jar is perceived in pumping engines working with a high expansion, it may be cured by increasing the weight or inertia of the beam.

For pumping a large quantity of water through an unusually great length of main pipe under a heavy pressure, the writer's experience has led him to prefer a description of engine consisting of a pair of high-pressure expansive double-acting beam engines, coupled together at right angles to one large fly wheel. The pumps should be of the combined plunger and bucket description, with Hosking's valves. There should be an air vessel and back flap valve to each pump, with a blow-off valve loaded to a certain weight, so that in the case of any recoil in so great a length of main, the pumps would not be burst. Along the main pipe, at each 50 feet of elevation above the pumps, the insertion of a back flap valve is required, so that in case of any pipe bursting the whole main should not be run dry. The leading point to be kept always in view in the design and construction of engines under these circumstances is the maintenance of a constantly uniform flow of water through the main pipe from the pumps. This is provided for by the compound double-acting pumps and the large air vessel accommodation, together with the coupling of the engines at right angles. The boilers should be similar to those of the Goldthorn Hill engine.

Many engineers prefer a double cylinder engine for conducting expansive operations; but although in some circumstances this may be advantageous, as for driving machinery where uniformity of power throughout the stroke is a desideratum, yet for large pumping engines the writer prefers single cylinder double-action engines. The arrangements with a double cylinder are much more complicated, and he finds that all useful degrees of expansion can be carried out sufficiently with a single cylinder.

A very cheap and effective description of temporary pumping engine for rough colliery purposes, where saving in first cost is a more important object than great economy of fuel, came some time since under the writer's observation at a colliery near Nailsea. The engine was constructed by Mr. Hughes, of the Uskside foundry, Newport, and consists simply of a large open topped cylinder placed vertically on two cross beams over the pit shaft. The working apparatus consists merely of a steam valve for admitting the steam under the piston, and an eduction

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valve for letting it out, with a steam slide throttle valve, and eduction slide throttle valve, for regulating the rate for the admission and exit of the steam. The two former valves are worked by tappets attached direct to the piston rod: the two latter are adjusted by hand, so as to regulate the number of strokes per minute, the engine being in fact its own cataract. This engine is remarkable for its simplicity and cheapness of construction, and has now been at work for some years. The consumption of fuel with a good description of boiler is not more than the average of ordinary colliery pumping engines as at present constructed. The general arrangement for a plunger pump would be as described above; with a lift pump it would be necessary to have a balance bob. Its security is also very considerable, since if the two throttle valves are properly adjusted, no great damage could occur should one of the other valves stick, as the piston could not travel either up or down faster than the steam could pass through the guarding throttle valve. It is also a portable description of engine, which is sometimes a recommendation in proving mines.

For raising water from mines in a district such as this, where fuel is abundant, a reduction in first cost is a much more important question than in districts where the fuel has to be imported at great cost; that is, setting the first outlay and interest for erecting a large expansive engine with low consumption of fuel against the smaller outlay with a larger expenditure of fuel, it will generally be found that, in districts such as this, the latter is better within certain limits for the party investing capital in opening mines. Everybody concerned in opening works of this description must be aware how important it is to economise first outlay, whereas when returns commence a small extra annual cost is not felt. Under the circumstances, in a district such as this, the writer would not recommend the erection of expensive Cornish engines for drainage purposes. Their first cost in every respect is very great; a cylinder and all machinery to match to do 1000-horse power work is put down to perform really only 200 or 250 horse-power, and all the parts of the ponderous machine have to be constructed of sufficient strength to resist the heaviest initial blow of the steam.

The plan of plunger lifts, carried out so extensively under this system, is not only expensive, but highly inconvenient in narrow pits. Whereas much the better and cheaper plan is a simple lift pump, with the beam balanced, so that the weight of the pump rods shall just carry the engine "out of doors." Plungers are in their place for forcing water above the level of the engine, as in the case of water works, but in the engine pit of a mine, with a strong and heavy rod having numerous guides and rollers, they are very inconvenient, and if the engine is properly balanced they effect no saving, as the piston must not travel faster than the rate at which it is safe to work the bottom set of rods, which must necessarily be attached to a lift pump.

Discussion.—In reply to an inquiry, Mr. MARTEN said, that the balls composing the valve were 2½ or 3 inches diameter, the apertures in the seat being 1 inch less; each ball was prevented from coming out of its place by a cap projecting from the seat immediately above, and by this simple arrangement, by slackening the top nut, all the rings and caps became liberated, and any of the balls could be taken out and replaced with great readiness.

Mr. FENTON said that he had seen the original form of Hosking's valve in work, and it was really a very good and ingenious invention; Mr. Hosking, the inventor, was engaged in the construction of the High Level Bridge at Newcastle, and the original form of the valve with india-rubber flaps instead of the balls had been used extensively in that neighbourhood, and was employed for common colliery purposes, with any sort of water, not clear water alone, and no difficulty was experienced from choking with dirty water; in this valve the india-rubber flaps were arranged in a pyramid, in the same manner as the balls.

Mr. FAIRBAIRN remarked that the Tettenhall engines had been described as cutting off the steam at only 2-3rds of the stroke, which gave rather a low degree of expansion, and left considerable margin for further economy in fuel by expanding to a greater extent.

Mr. MARTEN said that it was certainly a low degree of expansion, but there was no condensation, and the engines were direct-acting; a higher degree of expansion had been tried at first, but the action of the engine was rendered too sudden, and the violent blow of the steam caused the motion to be so remarkably quick in starting the stroke, that it was not found safe, from want of inertia sufficient to absorb the excess of initial force; this could only be supplied by having a beam, balanced on its centre, and offering no resistance to motion except the inertia of its weight, which acted as a regulator to equalise the moving power of the engine.

Mr. FAIRBAIRN said that he fully concurred in the value of a heavy balance beam as a regulator, and the disadvantage of the irregular motion that was produced by cutting off early, where not counteracted by the inertia of a heavy mass to be put in motion; and the observations in the paper on the comparative effect of a light and a heavy beam were very appropriate. In the case of the Tettenhall engines, he thought it would have been preferable to have a cylinder of larger size, and working with a higher degree of expansion, making the engine with a balance beam, if direct-acting, and employing the extra force of the steam to overcome the inertia of the load at the beginning of the stroke, relying upon the momentum afterwards to carry the engine to the end of the stroke.

Mr. MARTEN observed that the superiority of the heavy beam engine was well exemplified by the case of the two beam-engines that had been mentioned; they were both Cornish engines, but the one with a light open beam had a jar in its motion, and the engine gave a perceptible start or jump on starting each stroke; whilst the heavy beam engine worked smoothly and without a jar, and with 5,000,000 lb. more duty. In the Goldthorn Hill engine there had at first been a little jar at starting, but this was entirely removed by adding a balance weight of 2 tons weight upon each end of the beam. The reason for the Tettenhall engines being made non-condensing, was that these engines were the first erected, and the water having to be pumped out of sandstone rock, it was thought that there might not be much to spare for condensing; fuel also being cheap, the engines had been intended as a simple and economical arrangement for pumping. The ordinary standard of duty of Cornish engines had been employed, which was taken usually at about one million pounds raised one foot high per cwt. of coal for each inch in the diameter of the cylinder; and accordingly the Tettenhall engines, when considered as non-condensing, were working at a fair duty, having 36-inch cylinders, and giving 27,000,000 lb. with the common slack of the neighbourhood, equivalent to 36,000,000 lb. with Newcastle or Welsh small coal. Some saving of fuel has been effected by the plan of heating the feed water by means of the exhaust steam, but this might no doubt be rendered more important in amount by improved construction of the heating apparatus. After heating the feed water the waste steam had originally been thrown direct into the chimney, but in consequence of the stack having been considerably injured by the quantity of moisture in the foundations, caused by condensation of the steam in the chimney, it was now conducted into a well, where it was condensed, and a flue from the well to the chimney carried off the vapour rising from the water. The sand covering over the boilers had been found most satisfactory; the Tettenhall boilers had been originally covered with felt, but this partly rotted off, and was all removed, and the sand was then tried and had been employed ever since. The sand acted as a dry sand bath, being invariably quite dry within 2 or 3 inches of the boiler, and so hot that no steam that escaped could be condensed within that distance from the plates, and thus no corrosive action could take place. Much damage was often done to boilers by covering them with ashes or brickwork; in case of any steam blows, the steam was condensed in contact with the plates, and the plates were eaten through by the acid ingredients of the ashes, which were called into action by the condensed steam; he had seen some bad cases of boilers covered with ashes and brickwork, where the plates had been corroded very thin in a short time. A practical illustration of the value of covering the boilers was afforded by a pair of blast engines at his own works, blowing four furnaces. These were now supplied by four boilers covered with sand, and were giving a blast of 4 lb. per square inch pressure, with steam of 20 lb. pressure; but previously, when covered with a roof only, a blast of only 3 lb. per square inch pressure, was obtained, although five boilers were used. Common moulding sand had been used for covering the boilers, but the quality was immaterial, and any clean sand might be used. The sand was filled up level all over the boiler to a depth of a few inches above the highest part, and it had an important advantage over other modes of covering, in the facility which it afforded for examining any part of the boiler, as it was merely necessary to shovel away the sand from the part to be examined, which was as easily covered up again. In the case of the Tettenhall engines, steam blows had been left unrepaired for two years, in order to test the sand covering in a satisfactory manner; they had been frequently examined during that period, by shovelling away the sand in the manner described, and on arriving within a few inches of the boiler, the steam issuing through the sand was so dry, that it had not at all the appearance of steam, but rather of hot air blowing out; no signs of corrosive action on the plates had been detected in any case.

Mr. FAIRBAIRN remarked that the boilers had been mentioned as being constructed without any stays, and he quite agreed in the principle of depending on the form of the boiler for strength, and not upon artificial stays. The flues of the boiler at Goldthorn Hill had been described as of circular section, but elliptical at the fire-places, a plan which he had generally adopted formerly, but he made them now truly circular throughout, having found that there was no practical superiority in the working of the elliptical flues, and there was undoubtedly no form so correct as the circle. It was very important to ascertain exactly the relative strength of these forms, and he had the pleasure of stating that a grant of 300*l.* had been promised by the Royal Society for experiments, in which he was about to be engaged, to ascertain the strength of flues of various sections. He hoped the enquiry would be extended to an experimental investigation of the laws relating to the pressure and density of high

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pressure steam, as he felt convinced that the time was not far distant when the pressure employed for the ordinary working of steam-engines would have to be increased to three or four times the present working pressure.

Mr. FENTON observed that the experiments contemplated would be of great practical value; it was well known that the flue sometimes collapsed under a pressure per square inch much lower than that required to burst it; but by diminishing the size of the flue, it might be made capable of resisting a very great external pressure, as in the case of the tubes of locomotives, and it was very important that extensive experiments should be made in connection with this subject, in order to ascertain the law of strength and the correct form in all cases; as there must certainly be a definite relation between the crushing strength of a tube of 2 inches diameter and a flue of 2 feet.

ON THE RESEMBLANCE BETWEEN MEDIÆVAL AND CLASSICAL ART,

AS EXEMPLIFIED IN

THE GLASS PAINTINGS OF THE 12TH AND 13TH CENTURIES.

By CHARLES WINSTON.

[*Paper read at the Royal Institute of British Architects, June* 16.]

IT may be recollected that on a former occasion,* whilst adverting to the harmonious agreement between ancient painted glass and ancient Gothic architecture, I alluded to the resemblance which the glass paintings, contemporaneous with the architecture of the latter part of the 12th century and early part of the 13th, bore to the antique; and thus I concluded, from their agreement with the architecture, that we might contrive to produce modern glass paintings equally in keeping with early Gothic architecture, and superior to the old ones as works of arts, if, instead of merely copying these ancient remains, or perhaps barely correcting their bad drawing, we should strive to work up to those models of excellence which inspired the earliest Christian artists, and which have been admired, and, I will venture to say, will be admired so long as an appreciation of beauty shall continue to be a faculty of the human mind, although persons may occasionally be met with who seem to have been rendered insensible or indifferent to their merit by a too exclusive study of the mediæval art. In the discussion which these remarks occasioned, the propriety of illustrating my views by means of a drawing was suggested, and I agreed to resume the subject whenever I was prepared with such a means of explanation. I have been prevented from fulfilling my promise earlier, but the delay is not to be regretted, since it has afforded me more time for consideration. Even now I would particularly guard myself against the supposition that the drawing produced pretends to be a perfect exponent of my views. To carry out those views as I desire would require far greater artistic power than I can command; and therefore I must request you to regard it not by any means as a finished design, but simply as an explanatory diagram.

The influence which classical antiquity exerted on the arts of the West, principally through Byzantium, has been repeatedly insisted upon, and illustrated by modern writers. In some instances we are almost able to see the very track by which such influence was transmitted; in others it is impossible to forbear ascribing much to the effect of local remains, the fruit of a Roman occupation; in either case it is difficult to discriminate between the work of native and foreign artists. Still, however, a common resemblance points to a common origin. A variety of causes may unite to render this resemblance more palpable on some occasions than on others. But the wider the experience, the more positive is the belief in the Byzantine or Greek character of Western art in the 12th and 13th centuries.

From this influence ancient glass paintings are not exempt. They are infected by it in the same degree as other specimens of pictorial art. I am sorry I cannot corroborate by documentary evidence the opinion I have formed from the appearance of the painted glass. When and where the art of painting upon glass was discovered is still a matter of conjecture. The testimony of the earliest writer, Theophilus, by itself only shows that, at the time he wrote, France was, *par excellence*, the country in which it was practised. He tells his readers, that they will find in his book "all the knowledge that Greece possesses in the kinds and mixtures of colours; Tuscany in inlaid works, and the various kinds of niello; Arabia in malleable, fusible, or chased work; Italy in various kinds of vases, and the carving, enriched with gold and silver, of gems and ivory; *France in the precious variety of windows;* and industrious Germany in the delicate workmanship of gold, silver, copper, iron, wood, and stones." The Abbé Texier indeed—the author to whom I have had the most resort, because his inquiries are the most germane to my own pursuits—considers it probable that the honour of the discovery is due to the Limoges school of artists; and though his chief reason, the similarity of the process of enamelling to that of glass painting, of itself is entitled to little weight, especially if the opinion be correct that Germany shared with Limoges the manufacture of enamelled ware, the leaning of my mind, in the absence of any evidence to the contrary, is in favour of his opinion. Our not finding any specimens of painted glass earlier than the 12th century or the end of the 11th, and these nowhere except in France—so, far, at least, as I am aware of—affords a presumption that earlier specimens never existed, and that the commencement of the manufacture was in France. And I have long been of opinion that the glass used in the earliest glass paintings was made from Greek or Byzantine recipes, on account of its being so similar in texture and colour to the ancient Greek glass. Therefore (without, however, necessarily committing ourselves to the opinion that the art was discovered in France), I think we may safely conclude that it was discovered in Western Europe by some school of artists under Byzantine influence. Indeed, the very badness of the figure-drawing in the earliest examples, as compared with the excellence of the foliaged ornaments—and which, therefore, cannot be attributed, as in the case of the earliest enamels, to any peculiar difficulty in the manufacture—is an argument in favour of the discovery being made by a school of artists as yet immature, such as a provincial school might be considered in comparison with that of Byzantium. And by way of accounting for the spread and intensity of Byzantine influence in France, I may mention, on the authority of M. Texier, that as early as 979 a Venetian colony was settled at Limoges, for the purpose of trading with the spices and other commodities of the East, conveyed from Egypt by way of Marseilles. Mr. Fergusson, in his very useful handbook, corroborates the supposition that it was with Alexandria that the Venetians had their closest connection, though no doubt, as the great carriers of the Levant, they were, at that time, in frequent communication with Byzantium. To what extent the Venetians imbibed the Byzantine principles of architecture—in some degree modified by their commerce with Alexandria—is seen by reference to their great Church of St. Mark (a building remarkable, according to Mr. Fergusson, for being the only real specimen of Byzantine architecture within the limits of the Western Empire), and the Churches of St. Front Périgueux, the erection of which is ascribed to the Doge Orscolo I., who came to sojourn in France in 978, Souillac, Angouleme, Cahors, Solignac, Fontevrault Abbey, Fleac, St. Hilary of Poictiers, and others, all at no great distance from Limoges, attest, in their general architectural resemblance to St. Mark's, how thoroughly the colony carried with it the taste and arts of the parent State.

The Byzantine school, thus implanted in France, was during a considerable period continually having its traditions revivified and corrected by the influx of fresh artists, and new works of art from the East. Greek artists, it seems, were living there in the 13th century; and as late as 1421 an inhabitant of limoges brought with him an artist to carve a resemblance of the Holy Sepulchre, on his return, by way of Venice, from a pilgrimage to Jerusalem. If, then, glass painting were a French art, having its cradle in or in the neighbourhood of Limoges, we should expect to find its earliest remains displaying Byzantine features, and if so, the features, more or less strongly developed, of the antique; and wheresoever the birth-place of the art may have been, I assert that its earlier remains do display those features. The most careful observer can hardly fail to be struck with the resemblance between the glass paintings of and towards the middle of the 12th century, and the illuminations in the contemporary Greek MSS., or with the frequent recurrence in them of Greek ornaments; and the same general character may be traced in glass paintings until quite the middle of the second half of the 13th century, when it gradually died out, before the increasing influence of a new style, of which the sculptures in the choir of Lincoln, to which Mr. Cockerell has directed our attention, may be said to be an early and a favourable type. But the glass paintings which, on the whole, most closely resemble the antique are those which were

* See *Journal*, Vol. XVI. (1853) p. 190.

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executed between 1170 and 1240, or thereabouts. I am not seeking to deny that these works were executed by native artists either in France or England, but I cannot ascribe, as some have done, their greater freedom and closer likeness to good models, merely to the progressive improvement of a school. It seems more reasonable to suppose that the change was in a great measure caused by the influx of Greek artists, the greater aptitude on the part of their pupils to profit by instruction. The draperies, instead of being tightly wrapped about the limbs, and scanty in their proportions, as in the earlier examples, are more elegant and flowing, reminding one of the voluminous draperies of the antique; which they resemble not only in the set, but the very form of the folds, betokening a material thin in texture, and, from its pliancy, allowing the action of the limbs to be easily seen beneath it. The heads, too, more nearly resemble the antique in their contour. In one of the windows of Canterbury Cathedral, erected shortly after the fire in 1174 (the second window from the west, on the north aisle of the choir), are some heads which might have been copied from the old Roman. There are some similar ones at Lincoln, in glass, of the same date as that of the north rose, and now worked into it, though not belonging to it. There is also a strong resemblance to the antique in the fashion of the garments. It is well known that the Romans had in a great measure ceased to be the gens togata (Romanos rerum dominos, gentemque togatam) even in the reign of the Emperor Augustus. The lacerna, a cloak fastened on one shoulder with a clasp, and sometimes furnished with a hood, originally borrowed from the army, became, on account of its greater convenience, worn with the tunic, as the ordinary dress of the Roman citizen, and by degrees the toga was reserved for State occasions. After the removal of the seat of empire to Constantinople, a variety of additional dresses were used, many of them of Greek origin. The more stately of which were, with its usual tact, appropriated by the Church, as it gathered power, and which are the foundation of the Mass vestments of the Roman clergy at this day. This has been clearly demonstrated by the learned Krazer, whose accuracy, though it may have been painful to the High Churchmen, as showing the Pagan origin of some of the most sacred things, has never been impugned. Some of these dresses were, moreover, adopted in their courts by the barbarian conquerors of the Roman Empire, and thus were handed down to later times. The Dalmatic, in which the effigy of King John in Worcester Cathedral is clothed, is an instance, and the modern Peers' State robe is another. The most popular dress amongst those nations who possessed themselves of the territories of the Empire, no doubt was the tunic, with or without the lacerna, or a shorter cloak used by the private Legionaries, called the sagum; and this dress, with slight modifications, appears to have been in actual use in the 13th century. The mediævals almost invariably adopt the tunic with long sleeves in preference to that with short sleeves, which was the one usually worn by the Romans; and instead of the braccæ and buskins of antiquity, they clothed the nether man in long hose, over which they used shoes or long boots. So that, with the exception of the legs and arms being clothed, there is but little difference between an ordinary 13th century figure copied from glass, and a figure taken from the arch of Titus, or Trajan's column. The long tunic reaching to the feet, so common in the glass paintings of the 13th century, also had its prototype in Imperial Rome. The figures on the arch of Titus show that it was at that time often worn beneath the toga. Indeed, startling as it may appear, representations of the toga itself are to be found in pictures on glass of the 13th century; and I have little doubt in my own mind that the mantle which, carelessly thrown over the long tunic, constituted the conventional dress of prophets and of saints, not being ecclesiastics, throughout the middle ages—was, in fact but a corruption of the toga.

With regard to the ornament, it is easy by means of the carved ivories to trace the transition from the classical, to that used in the 12th and 13th centuries. It is so plain that the mediæval artists borrowed their ideas of ornament from the antique, and which being so purely architectural and conventional is on that account I think the finest of all ornament, that I shall not urge the matter further. Indeed, the thing speaks for itself. I shall, therefore, proceed without further delay to deduce a few practical hints from the facts I have stated.

The question that naturally arises is—if glass paintings whose drawing so much resembles the antique, completely harmonise with the buildings of the 12th and 13th centuries, would not other glass paintings equally harmonise with such buildings, whose drawing should more exactly resemble the antique in point of excellence? I say in point of excellence, for I totally disclaim any intention of recommending the substitution of copies of classical draperies or ornaments for mediæval ones, or exchanging the individual character, and strictly human, as opposed to God-like, expression of the countenance which distinguish Christian art, for the more generalised and conventional treatment of the antique. I wish to see the Christian sentiment elevated but not obliterated by a study of the antique, and the mediæval drapery drawn as the mediæval artist would have drawn it had he possessed the power of the Greek.

I am persuaded that if the same tone of colour which we see in ancient glass paintings of the 12th and 13th centuries be adopted, all archæological requiremen ts willbe satisfied by adhering to the costume of the period, and general form of ornament, and preserving the individuality and character of the heads. Thus the attitudes of the figures, the arrangement of the groups, and general cast of the features, might be taken as closely as possible from the antique, whilst the draperies should be treated as being thin in texture, voluminous, accommodated to the limbs, and moulded into deep simple folds. I believe that works executed upon this principle would often be taken for old ones of very superior quality. No doubt to achieve such works would require far higher artistic power than is generally now employed in glass painting, and a vast deal more time to be bestowed on their preparation than is now required, all which would tend to increase their cost. But having confidence in the common sense of the country, I believe if the matter were properly presented to their minds, that most patrons of glass painting would prefer possessing one picture window in a church, exhibiting a decent display of art, all the other windows being filled with good pattern glass paintings, instead of being content as now with having every window filled with the veriest trash under the denomination of pictures. The present want of artists to execute such works is no argument against the system, since we may be sure that plenty of artists would come forward as soon as they ascertained that their services were required. If the system is correct, there can be no insuperable difficulty in working it out.

SALISBURY CATHEDRAL.

On several accounts the alterations now in progress at Salisbury Cathedral are deserving of particular notice. This cathedral, so invaluable as a specimen of architectural symmetry, and as an example, almost unique, of a large building carried out nearly exclusively in one style, and that an *early* one, has—with the exception of the wretched spoliations and destructions effected by James Wyatt, at the close of the last century, and the loss of its bell-tower, which stood detached (as at Chichester) to the north-west of the edifice—escaped, better than most others, injurious tamperings; and therefore remains a peculiarly interesting and facile study for those who value art in its pure and primitive development.

At present, one of the most remarkable restorations of the day, viewed in its complete form, is in progress within the precincts of this cathedral, and under its very shadow: we allude to the chapter-house, under the direction of Mr. Clutton, as architect, Mr. J. B. Philip, as sculptor, and Mr. Octavius Hudson (whose services are given gratuitously), as colourist It may be in the recollection of some of our readers, that the advisableness of this restoration had become evident some years since, inasmuch as substantial repairs were sadly needed, and the movement was warmly advocated by the late Bishop Denison; still nothing practical was achieved during that prelate's lifetime. After his sudden decease, it was generally thought that no more fitting memorial could be devised than that of carrying forward the good work which the bishop was enabled only to set on foot: accordingly steps were taken with that view, and matters pushed so vigorously that the fabric is once more rendered perfectly secure, and its enrichments more or less revived, so that this noble pile was re-opened, with due ceremony, on July 30th.

Before, however, detailing what was to be, and what has been, accomplished, it may be well to give a general description of the building and its arrangements. As we have before said, it is architecturally consistent in style throughout, and it was probably erected during the prelacy of Bishop Bridport, who died in 1262, and with which period its various features fully agree. The plan is octangular, having a slender central shaft surrounded by eight smaller ones, in purbeck marble, and from these diverges the groining in every direction. The width of the chapter-house internally is 58 feet, and the height to the vaulting 52. It is approached, as usual, from the cathedral cloisters, which, in this instance, are square and very large, each ambulatory measuring 181 feet. The whole arrangement is very similar to that of Westminster Abbey, it

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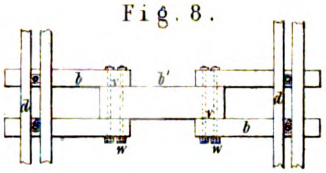
Symons' Wheels and Permanent Way for Railways.

Fig. 8.



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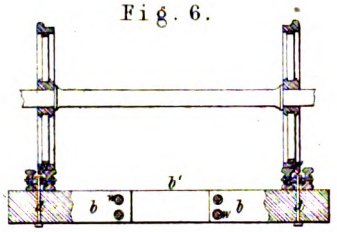

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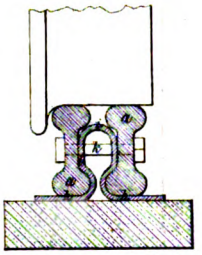

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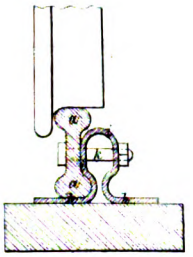

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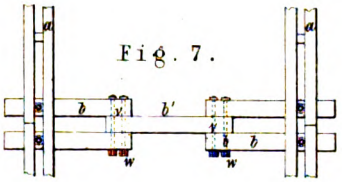

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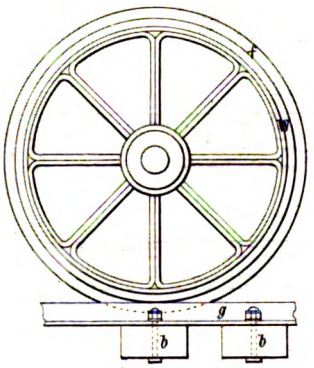

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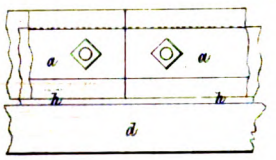

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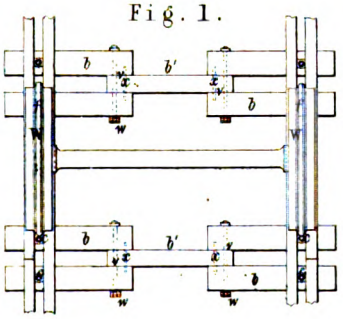

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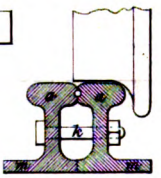

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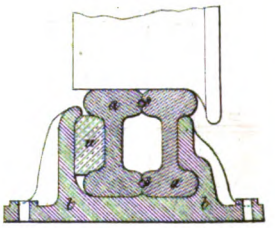

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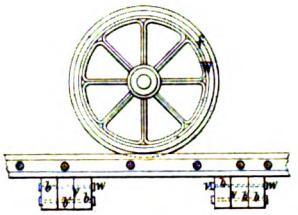

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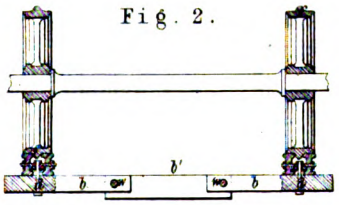

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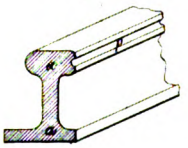

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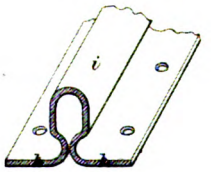

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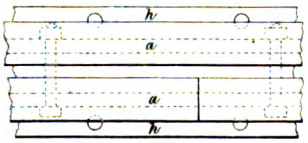

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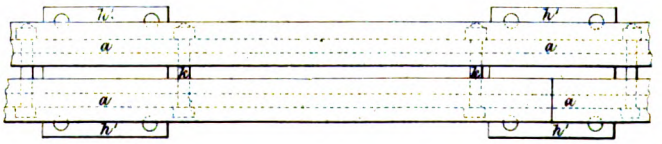


Glovers.-Breakwaters, Sea Walls &c.

Fig. 20.

Fig. 18.

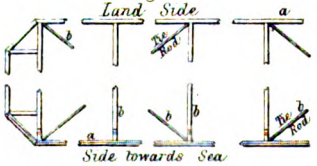
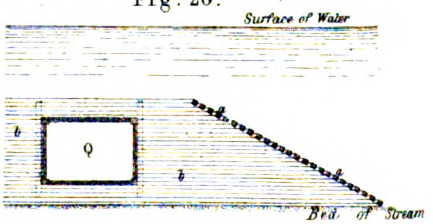


Fig. 19.



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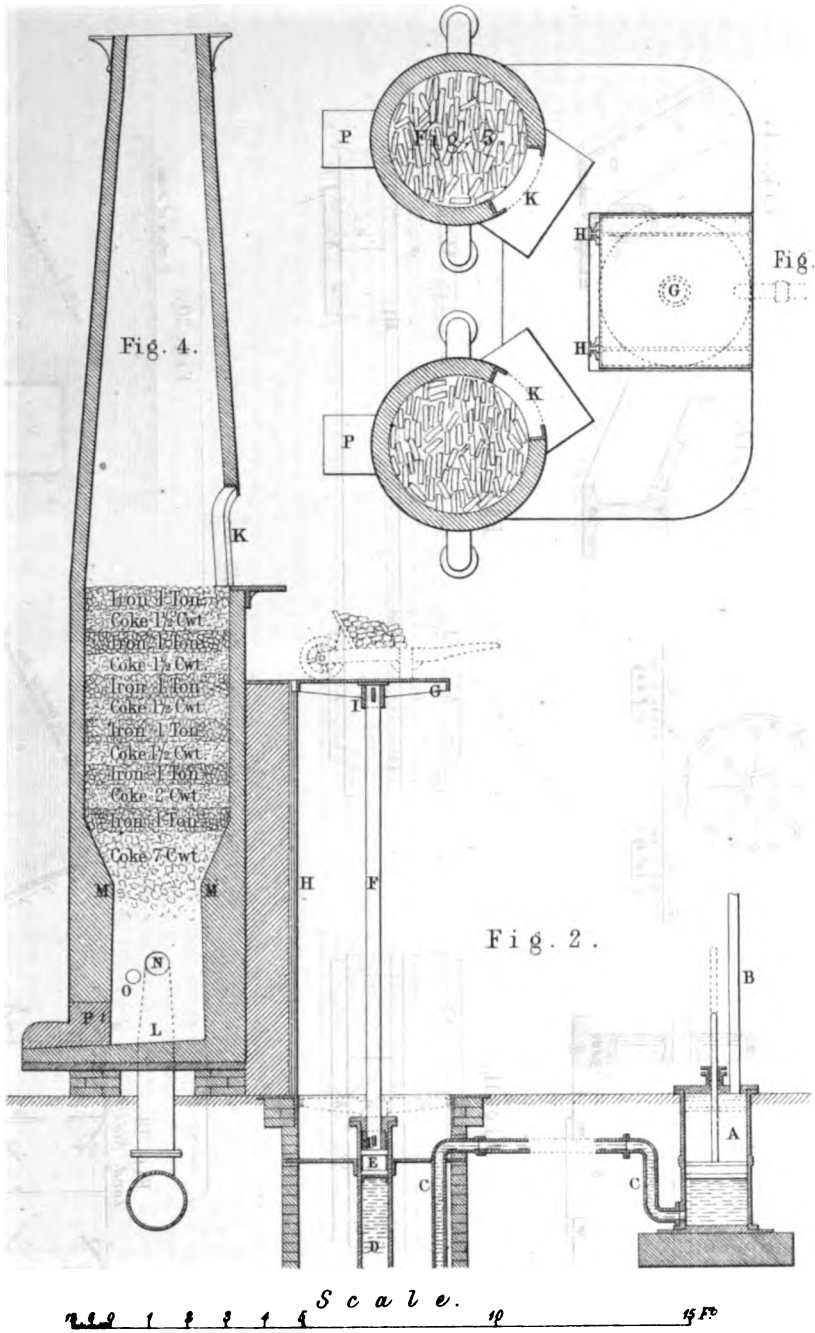
IMPROVED FOUNDRY HOIST AND CUPOLA.



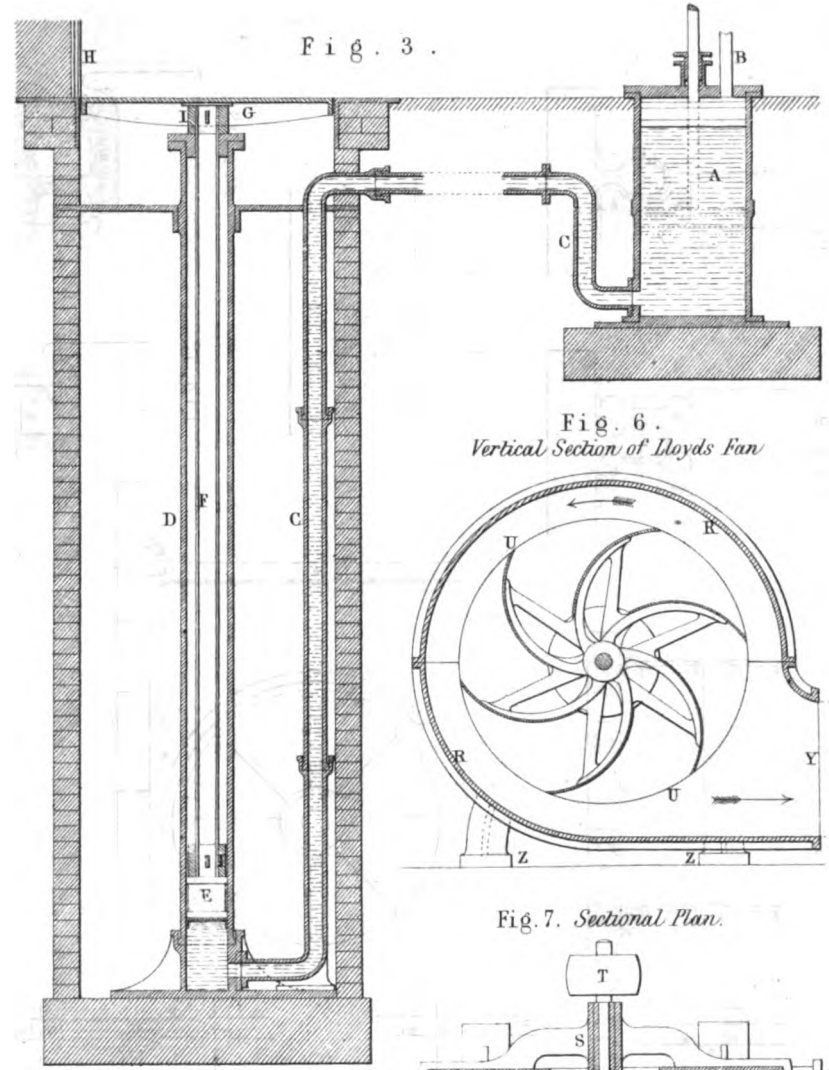
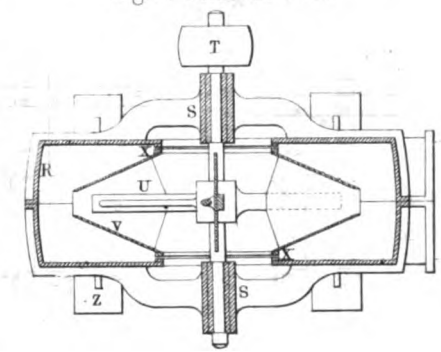


Fig. 6.
Vertical Section of Lloyds Fan

Fig. 7. *Sectional Plan.*



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being like that also on the south side of the edifice, and approached by the east walk of the cloister by a double doorway, communicating with an intermediate lobby. Internally, the walls exhibit six of the compartments nearly correspondent in character, the other two are of different form and appropriation. A stone seat or plinth is carried round seven of the sides, on that containing the entrance it being omitted; and, facing the latter at the east end, it is raised one step above the sides, and divided into seven compartments or deep niches, intended for the bishop, and six of his principal dignitaries; whilst the other thirty recesses round the room were for the canons, with a seat on each side of the doorway for the chancellor and treasurer. These seats are divided by pillars of purbeck marble, from which springs a continuous arcade, cusped, and highly enriched, in the spandrels and above, with sculpture. To this latter we shall have again to refer. Above the string-mould which surmounts this arcade rise the eight majestic windows, each of four lights, and having bold and simple tracery in the heads. The floor was originally a very handsome one, being paved with coloured pattern-tiles, many of which remain, and their arrangement is now again completed.

The structural defects reported on by the architect, previous to the late alterations, were as follows:—

1. The disturbance of seven out of the eight external buttresses.
2. The displacement of the vail walls over the windows.
3. The deflection of the central pillar to the extent of 9 inches from the perpendicular.

These defects were considered to have arisen mainly from one cause, viz.—the action of a south-west wind on a high-pitched roof, which, like York, Lincoln, and other cathedrals, it doubtless once possessed.—(The present roof is nearly flat, and does not form an architectural feature externally; it rests partly on the walls, and is partly strutted from a central post which stands on the marble pillars below).—The cause alluded to would naturally produce a strain upon the building in a north-easterly direction, and would also account for that peculiar twist which was perceptible in the north-east buttress and the central pillar. The celebrated spire of Chesterfield Church is a curious and well-known instance of a like result, as is almost every exposed wooden superstructure more or less. Owing to this, the buttresses, originally strong enough, became insufficient, and, in the latter part of the 17th century, tension rods were introduced to connect the walls and central pillar, thus greatly damaging the interior effect.

In the late restoration these difficulties have been boldly met; the buttresses have been altered, and now spread more at the base, so as to be better calculated to resist the thrust, the roof having been supported by temporary shoring (which we happened to observe was very scientifically contrived), the central cluster was wholly taken down and rebuilt, so that the objectionable tension rods could be dispensed with; the decayed stonework has been made good, also the purbeck shafts throughout—in themselves a wonderful improvement. The sculptures above the arcades, already noticed, and which contain a series of scriptural subjects from the creation to the overthrow of Pharoah's host, have been most accurately reproduced, where wanting, from the indicating remains, and present a valuable series, elucidating the conventionally crude ideas of the period in which they were designed. A small portion of this arcade and sculpture has been polychromed from the traces which remained of the original painting, and which were sufficient, it is believed, to reproduce it correctly; but funds have not permitted any extensive decorative works beyond the stencilling of the vaulting, and the polishing of the purbeck shafts. There yet remains also to be done, the restoration of the vestibule, and of the entrance doors from vestibule to the cloisters, and the whole of the stained glass. For these, it is presumed, about 3000*l.* will be required, of which the item of the glass will demand fully half. The outlay to the present time has been 4821*l.* 10*s.* 10*d.*, an amount exceeding the receipts by 234*l.* 16*s.* 5*d.*

It is a great satisfaction to find the work so thoroughly and successfully carried out, for designers and artificers are alike entitled to praise.

SURREY COUNTY GAOL.

Some alterations have been long in contemplation at this building, and are now entrusted to the direction of Messrs. Banks and Barry, as architects. The gaol at present comprises 134 separate cells, 20 association cells, 26 reception cells, and 38 male sleeping cells: total, 218 cells—a number which, under the circumstances, the governor considers sufficient

In the report submitted, it was proposed and resolved, "That the amended plans of Messrs. Banks and Barry, now laid before the Court, be approved of, and ordered to be carried out (subject to such modifications in the details thereof, as during the construction of the works may appear desirable to the committee to be introduced) at the sum (including architects' commission, purchase of furniture, and all other expenses), not exceeding in amount 12,000*l.*" "That (subject to the amended plans being certified by the Secretary of State) the tenders of Mr. John Wilson, for carrying out these works at the net sum of 10,361*l.*, be accepted, and that the Clerk of the Peace be directed to take the necessary steps for preparing the contracts, &c."

IMPROVED FOUNDRY HOIST AND CUPOLA.

(*With Engravings, Plate* XXVII.)

A Paper was lately read by Mr. John Fernie, of Derby, before the Institution of Mechanical Engineers, Birmingham, describing some improvements in foundry plant, consisting of an improved Hoist, the invention of that gentleman, combined with Ireland's Cupola and Lloyd's Fan, which have been lately erected under his superintendence at the Britannia Foundry, Derby, and have given great satisfaction.

The author proposed merely to describe the practical working of the above appliances, and to consider them especially in regard to their economical results. The fan, hoist, and sand and loam mills, are all driven by a small high-pressure engine and boiler, put up at the same time as the other plant. The steam is got up at 8·0 a.m. to work the hoist. The blast is put up at 10·0 a.m., and kept up till 1·0 p.m.; the fire is then damped down till 4·0 p.m., when the fan is again put on, and runs till 7·0 p.m. The engine, consequently, works six hours per day; and the sand and loam mills are speeded to do their work in six hours. The engine has a horizontal cylinder, 11 inches diameter, and 22 inches stroke, with 40 lb. steam, and the necessary speed for the fan is obtained by belts. The quantity of coal consumed per day by this engine, whilst driving the fan and sand and loam mills, is 6 cwt., and the total consumption with the addition of the hoist is 7 cwt. per day for two 5 ton charges of iron.

The improved Hoist, used for charging the cupola, is shown in figs. 1, 2, and 3, Plate XXVII. Fig. 1, is a general plan of the hoist, as arranged with a pair of cupolas working together; fig 2 is a vertical section of the hoist and cupola, showing the hoist raised in its highest position; fig. 3 shows the construction of the hoist in detail. A, figs. 2, and 3, is a steam cylinder, 20 inches diameter, fitted loosely with a piston, which has a range of 3 feet. Steam is supplied to the cylinder by the wrought-iron pipe B, of 1¼-inch bore, by means of a threeway cock, which admits the steam or allows it to escape as required. The exhaust pipe has a cock at its far end by which the time of the descent of the hoist is regulated. The cylinder is sunk in the ground, with its top level with the surface, and is surrounded with non-conducting material. CCC is a 4-inch cast-iron pipe, running from the bottom of the steam cylinder to the bottom of the hoist, a length of about 40 yards. D, is the cylinder of the hoist, 12 ft. 9 in. long, bored out from end to end to 8 inches diameter, and sunk in a well, the top being about 12 inches below the level of the ground. The piston or ram E, has a cup leather screwed on the bottom to serve as packing. F is the piston rod, formed for the sake of lightness of a wrought-iron pipe 3½-inch diameter and about ¼-inch thick, carrying at the top the light cast-iron platform G, 4 feet square, on which the barrow or wagon loaded with material is run. The platform is steadied in its ascent by the guides H; I I are india-rubber washers to break the shock of stoppage at top and bottom.

In working the hoist, the pipes CCC are first filled with water, till the piston of the steam cylinder A rises up to the top of the cylinder, the water being supplied through a wrought-iron pipe of ¾-inch bore from the force pump of the engine that drives the fan. As there is always a little leakage at the cup leather of the piston E of the hoist, the capacity of the steam cylinder A is made larger than that of the hoist cylinder D to allow for this loss, being nearly in the proportion of 2 to 1. The barrow or wagon being run on the platform, the steam is admitted on the top of the piston, and the hoist begins to ascend. For the first stroke or two, condensation takes place pretty freely, and the hoist rises slowly; but the cylinder and water gradually get warm, and after a few strokes no perceptible condensation takes place. The hoist ascends the 10 feet in 20 seconds, when loaded with 9 cwt., and descends in 30 seconds, the steam being turned on and off by the engine man; the men at the hoist make signals when they want the hoist to ascend or descend, and it begins to move immediately, with scarcely any perceptible loss of time.

The hoist was originally calculated to lift 10 cwt. at a time, the pressure of the steam being 40 lb. per square inch, and the diameter of the ram E 8 inches, making the total pressure upon it 18 cwt.; but it can take up conveniently only 9 cwt., and the weight of the platform, piston rod, and ram being about 3 cwt., there remains 6 cwt., or about 30 per cent., of which just so much is lost in friction as leaves an effective pressure sufficient to set the hoist in motion at the required speed. The writer tried to balance

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part of the weight of the hoist by a counterbalance; but this was ultimately abandoned, as it was found that 7 or 8 cwt. was as much as it was convenient to lift at once, and the hoist did not come down so quickly as was required, when too nicely balanced. An improvement might be made on the hoist, by the addition of a condenser attached to the exhaust pipe; the platform might then be perfectly balanced, and the descent made sufficiently rapid by condensing the steam on the top of the piston.

The inventor has made several experiments to ascertain the consumption of coal required to work the hoist alone; and has found that 1 cwt. per day, in addition to the usual quantity, 6 cwt., used by the engine, is sufficient to lift two 5-ton charges of iron per day. Before the hoist was used, as many as four labourers were employed during the whole day; but now two labourers fill up the cupola in two hours, their other time being spent in the foundry at cranes or carrying hot iron.

The hoist has now been at work 18 months, and during that time has lifted about 5000 tons 10 feet high. The only expense for repairs has been the cost of one new cup leather for the ram of the hoist, and one india-rubber buffer ring.

The Cupola, which is the invention of Mr. Ireland, of Manchester, is shown in figs. 4 and 5. It is capable of melting at the rate of 3 tons of iron per hour. The height from the floor to the top is 27 feet, and from the floor to the level of the charging door K 12 ft. 6 in. The shell is parallel from the ground to the charging door, and thence it gradually tapers up to the top. The outside diameter is 4 ft. 6 in. in the cylindrical part, and 2 ft. 6 in. at the top. The inside diameter is 2 ft. 6 in. at the bottom of the crucible, on the cupola hearth L, contracting to 2 ft. 3 in. at the springing of the boshes MM, and 3 ft. 9 in. from the boshes to the charging door, whence it tapers to 1 ft. 9 in. at the top. The height of the crucible is 4 ft. 3 in., and of the boshes 1 ft. 8 in., and the height from the boshes to the charging door is 6 ft. 3 in. From the top of the boshes to the top of the cupola the lining is formed of a single thickness of firebricks, which is quite sufficient, as practically there is found to be very little wear above the top of the boshes. The centre of the blast hole N is 2 feet from the bottom of the cupola, and the hole is 9 inches diameter, to admit of a 7½-inch tuyere. O is a slag hole, 5 inches diameter, the top of which is level with the bottom of the tuyere hole. P, is the tapping hole, which is made in the usual manner.

In charging the cupola in the morning, a small fire is first made at the bottom, as in the old cupola, and then 7 cwt. of coke is put in. The top of this should be carefully levelled, which is easily done in throwing in the last few skips. On the top of the coke 1 ton of iron is thrown in, the pigs being broken into three or four pieces each, which are thrown on with their length parallel to the direction of the blast, as shown in the plan, fig. 4, leaving a space immediately over the tuyeres for the scraps that are to be melted. The next charge is 2 cwt. of coke, the top of which being levelled as before, 1 ton of iron is again thrown in, the pig end lying in the direction of the blast as in the first charge, and the scraps are added over the tuyeres. The next charge is 1½ cwt. of coke, then 1 ton of iron, and these charges are repeated till sufficient metal has been laid on. The cupola is ready for blowing as soon as it is charged up to the door, as shown in the figure; it then contains 6 tons of metal, and 15 cwt. of coke, or 2½ cwt. of coke per ton of iron. The first charge in the afternoon is rather less than that in the morning; a portion of the coke used in the morning is saved, and the cupola being still warm, less is required at starting. The first charge is 5 cwt. of coke, after which the charging is the same as in the morning, giving a consumption of about 2⅛ cwt. of coke per ton of iron. Hence the mean consumption for the whole day is about 2¼ cwt. of coke per ton of iron. The charge of flux consists of ½ cwt. of Derbyshire spar added on the top of the second and fifth charges of metal, the same being added at every third charge of metal afterwards. The slag hole is kept open nearly all the time of blowing, and has a spout from it, running off into a small wagon.

The repairing of the cupola is done every other day; the brick work just above the tuyeres becomes hollowed out by the action of the blast, and the cupolas are accordingly charged only every other day. When 24 tons of metal have been melted, amounting to two days' work, the repairs that are then ordinarily required take on an average 12 to 20 bricks, about ½ cwt. of fire clay, and 2 or 3 hours' labour. The cupolas on this construction at the Britannia foundry have been nearly two years at work, and have given great satisfaction; they save nearly half the coke that was formerly burnt in the cupolas on the ordinary construction that were previously used in the same place. The bricks used are from Stourbridge and the coke is from Elsecar.

The superiority of Ireland's cupola over the whole construction consists in the shape of the interior, the height, and the perfect system of charging. Owing to the shape of the interior, the charges are kept up by the boshes M M alone, and as they gradually descend the incline, they are melted; consequently the only portions of the lining of the cupola that are subject to wear are the boshes and the sides of the crucible. The advantage of the height of the new cupola is evident on comparing it with some of the old cupolas, in which the height from the ground to the charging door seldom exceeds 8 feet, and in many cases is not more than 6 feet, instead of 12 ft. 6 in., as in the new cupola; consequently a great portion of the heat is lost at the charging door, which is retained in Ireland's cupola; and as all the heat has to pass up through the charges, the iron above is gradually warmed as it descends.

The mode of charging the old cupola could hardly be denominated a system. The quantity of the iron was estimated by the gross weight, or was guessed at; and the coke was seldom or never weighed. The iron was thrown on without any method, and the coke was added at the caprice of the man in charge of the cupola. If he thought the iron looked cold an extra skip full or two of coke was thrown on, and he was not very particular whether he threw in more iron on the top of the coke or not. By the old method, the cupola was ready for blowing as soon as two or three charges had been put on, and a large portion of the heat was consequently lost; in Ireland's cupola the last charge must be thrown in before the blast is turned on, and the heat therefore passes from the first through the whole of the charges, so that very little is wasted. In the opinion of the writer, the quantity of coke used in this cupola is the minimum amount sufficient to melt the iron; for on two separate occasions when the blast was put on rather too soon, before the cupola was completely charged, there was great difficulty in getting the iron to run at all, and towards the end of the charge the front of the tapping hole had to be pulled down, and the iron was drawn out only partly melted. The heat rising from the lowest part of the charge, instead of being retained by the top charges, had been allowed to escape, thus causing the half melted state of the upper portion of the charge.

The cupola is blown by a Lloyd's Fan, shown in the vertical section, fig. 6, and plan, fig. 7. R is the outer case, cast in four parts, the two upper of which are bolted permanently together, and also the two lower. The horizontal joint through the centre admits of access to the internal parts without disturbing the foundations. S S are the bearings, and T the driving pulley. U is the internal revolving case, called the impeller, having sheet-iron discs V V fixed on the side edges of the blades. X X are turned brass rings fixed on the discs, and fitting up against cast-iron rings bolted on the outer case, forming the centre opening through which the air enters the fan. Y is the discharge pipe, and Z Z the feet on which the machine stands, and by which it is bolted down to the foundations.

The difference between this fan and those of the ordinary construction consists in the form of the internal part U, which may be described as a revolving case, having six curved arms cast in one piece; on these are screwed curved sheet-iron blades, of the form shown in fig. 4, on the outer edges of which are fastened the sheet-iron discs V V, previously mentioned. The total area of openings at the circumference, as also the total sectional area of the internal passages at any distance from the centre, is equal to the areas of the two central openings in the sides of the outer case.

In the paper on the Fan Blast, read by Mr. Buckle to the Institution, he entered into the origin of the objectionable noise which always attends the old fans. He found that by altering the area of the passage into the discharge pipe, by the means of a segmental slide attached to the fan chest, the noise was very much reduced, when the area was equal to the area of the tuyeres. By lowering the slide till it was level with the underside of the tips of the vanes, nearly the same quantity of air was impelled as with the original opening, and the noise from the fan had nearly ceased. It therefore appears, as remarked in his paper, "that the less this opening is made, provided we produce sufficient blast, the less noise will proceed from the fan; and by

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making the top of the opening level with the tips of the vanes, the column of air has little or no reaction on the vanes."

It may be observed, that the principles demonstrated in Mr. Buckle's experiments are carried out in this fan, although in a different manner. The discs V V prevent the reaction of the air on the sides of the blades, and the area of the tips being so much reduced, there is little surface for the blast to react upon at the tips, and hence the fan is almost noiseless. The pressure of blast at 1400 revolutions per minute, supplying two 7-inch tuyeres, is equal to 8 inches of water, that is 8 inches rise and 8 inches fall of the water in the guage, making 16 inches total, or 9 ounces pressure per square inch; and at 2000 revolutions per minute, supplying two 8 inch tuyeres, the pressure is equal to 12 inches of water, or 24 inches total, equivalent to 14 ounces pressure per square inch. The first of these pressures, 8 inches of water, has always been found by the writer to be more than sufficient to melt from 2 to 3 tons of iron per hour.

The coke consumed per ton of iron melted in the cupola may be set down at 2½ cwt. for ordinary working; but in continuous working, such as railway chair work, the average might be brought down as low as 1¼ cwt. of coke per ton of iron, while the coal consumed for driving the fan and hoist, and sand and loam mills, should not exceed ¾ cwt. per ton of iron.

Discussion.—In reply to various questions, Mr. FERNIE said he had not had an opportunity of experimenting with fans having parallel blades, and consequently could not speak of the comparative advantages of the different forms; but he thought the casing round the blades gave a superiority over the ordinary fan with open blades. There was no humming noise perceptible at any speed, and the clicking of the belt was the only sound to be heard; the fan was 3 feet diameter in the revolving part, and the highest speed at which he had seen it driven was 1400 revolutions per minute, the ordinary working speed being 1000 revolutions a minute. No lubrication was required except for the journals, as the fan was made just to swim clear of the outer case; the journals had a long bearing surface, and were free from end play, preventing the fan from coming in contact with the outer case; no leakage of air was perceived at the joint, though it was not quite close. The revolving portion of the fan was light in construction, which was an advantage, the blades and discs being thin, and the arms also thin, being all cast in one piece.

Mr. FOTHERGILL observed that from the investigations in Mr. Buckle's paper it appeared that the noise might be effectually prevented in fans having flat and parallel blades, if properly proportioned. In Schiele's fan the blades were more curved towards the outer extremities, and the air was drawn in on one side only, and expelled at the centre of the opposite side. In the fan recommended by Mr. Buckle the blades were flat instead of curved, and of equal width, any rebound of the air after delivery from the blades being prevented by making the outer case of a spiral form, increasing the space beyond the blades till it reached the size of the discharge opening.

Mr. H. WRIGHT confirmed what had been said of the absence of noise in Lloyd's fan; he had had one at work for some time, and it had proved very satisfactory. The fan was driven by only one strap, instead of two as frequently used, and he thought that plan preferable, as the tension of two straps could not be kept exactly equal.

Mr. COCHRANE had one of Ireland's cupolas in use, and it had proved quite satisfactory and economical in fuel, if worked with complete regularity; he had had it at work for three or four years, but had found that it could not be worked so economically as had been stated, 1¾ cwt. to 1¼ cwt. of coke per ton of iron being quite the lowest amount to which he had succeeded in reducing the consumption, the cupola being charged with care in the manner described in the paper. He thought it a very good construction of cupola.

Mr. FERNIE said that Mr. Ireland stated he had reduced the consumption to 1¼ cwt. of coke per ton of iron, when the cupola was employed on regular continuous work, as in casting railway chairs; but in his own experience, with less regular work, he had not been able to get it lower than about 2 cwt., as stated in the paper. He believed there were about ninety of the improved cupolas in use, some of which had been at work for five years; he was not aware that there were any in that neighbourhood, but several had been put up at Manchester.

Churches and Schools.—A return just printed, on the motion of the Marquis of Blandford, M.P., shows that the sums granted during the last ten years for the erection of churches and schools, by various public offices, were as follows, viz.:—By the War-office, 1600*l.*; by the Ordnance-office, 2185*l.*; and by the Customs, 715*l.* A list of sums granted by the Church Commissioners is also given, but no total has been cast up by the compiler of this part of the return, which occupies a space of five pages.

NECESSITY FOR ARCHITECTURAL INSTRUCTION FOR OTHERS BESIDES ARCHITECTS.

THOUGH we ourselves do not touch upon matters political, we are far from complaining when we find those to whom they properly belong, touching, as they frequently have done of late, upon matters architectural; we charge them not with trespassing upon our manor. Stumble, indeed, they sometimes do, and flounder about rather awkwardly; but that is their affair. If they do not always speak very judiciously, their speaking about architecture at all shows that they consider it worthy of being spoken of, and of having the attention of the public directed to it. In what they say there is at present generally too much of tirade; yet even smoke gives indication of fire existing somewhere. In like manner, the appearance of "leaders" in the *Times* and other papers, upon matters bearing upon architecture, may be taken as a sign that such topics begin to possess a more general interest than they formerly did.

Very much, however, remains to be done ere architecture can be duly appreciated by the public in its character of art, and as such be properly encouraged. Without adequate taste and judgment on the part of the public, that which there may be in the profession will be placed at a great disadvantage. By the public we mean the educated classes, from whom those are taken who exercise a direct influence upon architecture in the capacity of its employers, whether on their own account or that of others; or an indirect one through the authority attached to their opinions and teachings. It is but too notorious that those who are entrusted with the power of deciding which out of a number of designs sent in to a competition shall be the one adopted for execution, show themselves, quite as often as not, sadly deficient in the qualification for such important office. They seem to think that all they have occasion to understand is to know what they themselves like—what hits their own untutored fancy just at the time; and their ignorance and indifference occasion what is the greatest misery of all in architectural competition, that of not only having toiled to no purpose, but of seeing the prize awarded to a decidedly inferior production. As to those who act as judges on such occasions, however honestly they may do so to the best of their capacity, little can be said for their honesty in undertaking a charge which they are unprepared for by previous study. Scarcely any one of sound mind who had not given more than ordinary attention to painting, would venture to give a formal and decisive opinion upon a picture; neither would any sane person think of abiding by it. With respect to architecture, it is quite different; for, notwithstanding that some elementary knowledge of it is absolutely necessary to enable any one fairly to understand the whole of a design when shown in a series of such conventional drawings as plans, elevations, and sections, many to whom they are all but a complete mystery make no scruple of doing much more than expressing a mere opinion, which, if foolish, would be harmless,—of giving one that, be it ever so foolish, carries with it a certain degree of weight, and may chance, along with others of the same kind, to determine the ultimate decision.

It would seem, then, to be to the interest of both architecture and those who practice it, that *some* at least among the public should be competently acquainted with it as art. Yet how are those *some* to be found just when wanted? Or how are those who are called upon on a sudden emergency to select a design to prepare themselves for the express occasion, if until then they have been quite unprepared? However ignorant and indifferent the rest of the public may be, it is most important that those with whom rests the selection of designs for public edifices should feel sincerely anxious to do themselves credit. The noble cathedrals erected in the middle ages show plainly enough that their first founders and those who followed them were in earnest, and took a lively interest in the respective works. They may, perhaps, have been actuated quite as much, if not more, by astute policy as by real love of architecture for its own sake, but they certainly felt it to be decidedly to their own interest, to that of the Church and the ecclesiastical order, to do their very best. Architecture was with them a matter of such vital concern, that they could not afford to be careless and indifferent. Their solicitous study of the art enabled them first to conceive the edifices which are now our models, and afterwards to direct and superintend their execution.

Were anything like similar solicitude to do the best that circumstances permit, shown now-a-days, we should not see so many favourable opportunities all but entirely thrown away. To say

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the truth, an architect has now to take measure of the prejudices and obstinacy of those who have the power of dictating to him or else of rejecting him, for no other reason than that his ideas do not exactly tally with their commonplace notions; to the level of which he must accordingly work down, unless he boldly makes up his mind to the desperate risk of "neck or nothing." How, indeed, can it be much otherwise so long as those who employ, or who have a voice in appointing an architect to a particular work, are themselves wholly uninstructed in architecture? Unless there be some corresponding degree of *passive* talent on the part of the public, such as would enable them to estimate and relish what is produced by the *active* talent of the architect, the latter is pretty much in the condition of a painter who exhibits his works to those who can scarcely see, or of a musician who plays to those who are all but completely deaf. And such is likely to be the case with the architect, until a far larger class than at present of those who are not architects, become sufficiently acquainted with architecture as art, and able to judge of and enjoy it as such.

Professional men have, unfortunately, entertained other views of the matter, and those neither the most liberal, nor the most long-sighted. Shutting their eyes to the fact that the more widely a taste for architecture is diffused among those who do not belong to their own class, they have in their writings and publications addressed themselves almost exclusively to those who do belong to it. They generally, too, appear more desirous of displaying their own learning than of rendering the study attractive to those who, were it treated popularly and at the same time properly, would perceive it to be fraught with interest, and worthy of being taken up solely for the sake of the gratification it affords.

In our opinion, architecture—that is, its rudiments—ought to form a part of school education, in like manner as astronomy or geography; and architectural drawing be taught just as well as "the use of the globes," if only as affording practical exemplification of applied geometry. One good result would be that those alone would embrace architecture as their future profession, who felt decidedly attracted towards it by their school-acquaintanceship with it. Nor would the study have been wholly thrown away even upon those who were destined for other pursuits; because, either they would, prompted by natural inclination, have obtained such insight into the art as to be able to take unaffected interest in it; or else, feeling no taste for it, they would dismiss it along with "nonsense verses," and a good many other things, as one of the bores of their schoolboy days.

One of the great and very peculiar difficulties with which the architect has now to contend is, that the language in which he is necessarily obliged to clothe his ideas, is to the public little better than an unknown tongue. A painter can produce his works in a complete state at once, whether he has a commission for them or not; but the architect can, in the first instance, show no more than *intentions*. He may design palaces, but he cannot erect them, unless engaged to do so; therefore, until actually commissioned to begin operations, he can show only preparation for performance, instead of performance itself. Whereas, too, a picture is seen as a whole, a design for a building requires to be explained by a series of separate drawings, some of which are so technical and of such peculiar kind as to be rather puzzling to those who are not tolerably familiar with them. Besides which, each has to be examined and considered first by itself, and afterwards with reference to all the others: and that it is very possible for non-professional persons to do, provided only that they are capable of *reading* what is presented to them in such shape, and of forming in their own minds a distinct image of the entire design. Such being the case, it is on every account desirable that those who are any way concerned with architecture should be conversant with the modes of graphic description employed for it. Neither is it less desirable that others should be equally competent to understand them—not that that alone is sufficient.

The question of *Cui bono?*—should any one think of putting it, and asking what is the use of studying plans, &c., to any but architects or those likely to employ them—is easily answered by putting similar ones: What is the use of looking at pictures, and understanding paintings, except to those who, if they do not produce them, purchase them? What, again, is the use of understanding music, except to those who practise it? Yet, though such questions contain their own answer, the reply to the *cui bono* does not seem to be equally prompt in the case of architecture. The last, it seems, may be left entirely to those who practice it—a most mistaken notion, and so prejudicial that, so long as it prevails, architecture is deprived of that *con amore* sympathy with it which an adequate intelligence of it would produce. In regard to the *art*, the non-professional ought to be on the same level as the professional man; the more instructed in it is the former, so much the better for the other. Persons who have never penned a verse may be excellent judges of poetry—better ones, perhaps, than some who call themselves poets. So is it too, and so should it be understood to be, with regard to architecture. And there is at least one in the profession who is quite of our way of thinking—would that all who belonged to it were the same. "If," says the writer alluded to, "the architect alone understands what he has done, he has laboured to very little purpose; nor can he be expected to labour with any severe regard to critical perfection unless he can reckon upon public appreciation as his reward." To have no public, no other judges than his "peers," *i. e.* his professional brethren, who are not likely to proclaim his superior ability very loudly, must be most discouraging to him who, conscious of being gifted with talent, has, if without what is called "a connexion," to wait for what may, perhaps, never come—an adequate opportunity of displaying it. He may, indeed, send in to competitions, and reap the mortification of finding a very commonplace design preferred to his own.

Another evil, and no small one, arising out of the general ignorance of architecture, is the flippant stuff passed off as criticism by those who, feeling confident that the public cannot detect their shallowness, say whatever suits their immediate purpose, without so much as pretending to offer anything like valid reasons for either their praise or dispraise. "Is not the critic, in short," says the writer already quoted, "too frequently one of the general—we may add ignorant, public, with no advantage over his readers beyond that of a ready pen, and a reckless promptitude to give it license?"

Buildings we must have, but our having architecture—not merely at second-hand, either copies of or compilations from former works—depends in a great measure upon the public becoming far better instructed in it than they are at present.

REGISTER OF NEW PATENTS.

(*With Engravings, Plate* XXVIII.)

INDURATING MARBLE AND STONE AND FIXING COLOURS THEREIN.

H. C. Page, Sculptor, *Patentee*, November 1, 1855.

This invention consists, firstly, in an improved method of indurating marble and stone, so as to render them impervious to atmospheric changes, the action of smoke, grease, and such liquids as usually stain marble and stone, and also to render them less quickly acted upon by acids than marble or stone, as heretofore generally prepared; the object being to perpetuate the beauty, colour, and value of marble and stone, and to preserve the sharpness thereof when sculptured.

Secondly, in adapting the indurating or preparing process, to the fixing of colouring matters applied to marble or stone for ornamenting the same with a variegated pattern or device. Marble or stone prepared accordingly is found in practice better adapted for writing upon than heretofore. By writing is meant cutting letters in marble and stone and afterwards gilding or colouring the same, as the colouring matters employed will neither spread nor become absorbed by the stone, as is the case with stone as heretofore prepared, and this mode of writing is considerably cheaper and more durable than the ordinary mode of writing on marble and stone.

To indurate light-coloured stone and marble the patentee proceeds as follows:—With a clean soft brush or sponge the surface of the marble or stone is wetted with a solution composed of two parts of lime and one part pearlash; the stone is then exposed to a gradual heat until it is perfectly dried through, and until it has become sufficiently hot to melt white bees-wax, which is passed quickly over the surface thereof, using either lump wax or flake wax, as in practice may be found most desirable. Should the stone or marble be very porous, it may then be necessary to pass the wax two, three, or more times over the surface thereof, and if such surface be polished it should be cleaned off by

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rubbing with a dry soft rag while the stone is warm, until the surface is perfectly clean and free from dirt and surplus wax. The stone is then cooled by pouring cold water thereon, and when cold is finished; and marble and stone thus prepared or indurated is found to resist the most penetrable oils or stainable liquids. Great care should be taken when the solution is first applied to have the surface of the marble or stone perfectly clean and free from dirt and dust; at the same time it is immaterial whether or not the stone be perfectly dry. Care should be taken while heating the stone for the second or waxing process, that no soot, smoke, or grease come near it. The operator should also avoid touching the surface with his hands, as even the moisture therefrom would leave an indelible mark or stain. Care should also be taken to have the wax as pure as possible, otherwise the stone will be liable to change colour after a time.

The improved process for producing a variegated pattern or device in colours on marble and stone is as follows:—The surface of the marble or stone to be operated upon should be clean and fine, but not polished. The colouring matters are applied to the surface, and are disposed and arranged according to the taste and skill of the artist, in imitation of coloured marble, or any particular pattern or device; after which the stone is subjected to a sufficient degree of heat to melt wax when applied thereto, as before stated, and when so applied the colouring matters will become perfectly fixed, and remain so for an indefinite period of time, without fear of spreading or intermixing the colours one with the other. When it is desired to preserve the natural colour of any part of the surface of the marble or stone in the production of a variegated pattern or device, the patentee proceeds as follows:—To the entire surface of the marble or stone a solution of potash and lime is applied, as before described, and the marble or stone afterwards heated, as before stated; white wax is then applied to those parts of the surface of the marble or stone which it is desired to preserve in its original colour; and to the other parts of the surface of the marble or stone, while warm, the colouring matters necessary to produce the desired design, pattern, or device. In operating with such colours as would be prejudicially affected by heat, it will be necessary that the marble or stone should be allowed to become cold before applying such colours thereto; after which, the stone is again heated, more wax is passed over the entire surface thereof, the surface cleaned, and the process is finished.

The method practised of indurating common stone work generally is thus described:—One pound of calcined bees-wax is dissolved in one gallon of coal-tar naphtha, and with an ordinary painter's brush passed repeatedly over the surface of the stone so long as the stone will absorb it, and until the pores are filled therewith. Should the stone be unusually porous, it will then require the solution to be run quickly over the surface thereof three or four times in succession, using the solution proportionately thicker for coarse stone than for fine stone. The surface is then cleaned with pumice-stone or other fine grit and clean water, and the process is finished. When it is desired to preserve the natural colour of any particular part of the surface of common stone in operating thereon to produce a variegated pattern or device to those parts of the surface the solutions of coal-tar naphtha and wax, before mentioned, are applied, and the colouring matters to the other desired parts of the surface of the stone, and finally the solution of coal-tar naphtha and wax is again poured over the surface; the surface is afterwards cleaned off, and the process is then finished, the process in this instance being conducted without the aid of heat. The above method of indurating stone will not apply to marble or limestone, or any other description of stone that contains a large quantity of lime for its basis. In operating upon these qualities of stone when very delicate in colour, the indurating process requires to substitute double-distilled camphine in place of the coal-tar naphtha, above mentioned, the said camphine being mixed with the wax, in the proportion of one gallon of camphine to each pound of white wax; when the colour of the stone is not delicate, then the ordinary camphine of commerce will answer the purpose.

Lastly, stone and marble indurated by the above processes is well adapted for all kinds of ornamental carving and letter cutting; the stone is less liable to chip than heretofore; and further, in lieu of requiring to use a delicate camel's-hair brush and spirit varnish to fill in the letters, with the colouring matters employed by the improved method of indurating, oil colours may be dashed indiscriminately over the stone, and the surface afterwards simply cleaned, thus rendering the operation of letter writing or colouring on stone and marble more simple, expeditious and durable than heretofore.

Claims.—1. The mode set forth and described of indurating marble and stone.

2. The mode set forth and described of permanently fixing colours in marble and stone.

3. The mode set forth and described of indurating all kinds of common stone work, substantially set forth and described.

SHEATHING SHIPS.

J. H. Johnson, *Patentee*, January 22, 1856.—(Communication.)

This invention consists in the employment of plates of cast or shear steel for the purpose of sheathing or covering ships' bottoms in place of the sheets of copper, zinc, Muntz metal, or other material at present employed for that purpose. The sheets of steel are rolled out to the desired size and thickness by strong and powerful mechanism, and are applied or attached to the ship's surface in the manner ordinarily adopted. Many advantages are gained by this invention; the cost of the steel is not more than one half that of copper, and not more than that of zinc, whilst its strength is much greater, and it is therefore more fitted to withstand shocks or friction which would tear or otherwise destroy the sheathing now in ordinary use, and at the same time the improved sheathing resists the action of the water to the greatest possible extent.

PERMANENT WAY OF RAILWAYS.

Thomas Symons, *Patentee*, November 29, 1855.

The improvements patented consist, first, in the use of a double line of rails, or twin rail, instead of the single line of rail, now used. For this purpose two H rails are placed side by side, with sufficient room between them to receive the flange of the wheel, which is placed in the middle of the breadth of the wheel, and allowed to bear on both sides of the flange, and consequently on both rails. This is only necessary with regard to the engine wheels, as a bearing on a single rail will be sufficient for ordinary carriages; in these the flange is made on the outside, so that it should bear on the inner rail, the flange having a bearing on each side to keep it on the track. The H rails are fixed together by short bars at the middle of their depth, and by bolts through such bars are held down to the sleepers, chairs being altogether dispensed with; double rails of any other form may be used in lieu of the H rail. Instead of placing the double or twin rail with the bearing surfaces at a distance apart, with the driving wheel flange running between them, the parts of the rail may be placed in closer proximity, and the flange of that wheel placed on the inside of both rails, the wheel at the same time having sufficient breadth in the sole or tread to cover and bite throughout the breadth of both rails.

Another part of the invention refers to the sleepers, which are made in pieces instead of one piece, as now, laid transversely to the rails. For the sleepers five pieces of wood of equal length and size in cross section, about 8 inches by 4 inches are used, two of which pieces are placed on edge under each rail, at a distance apart equal to the thickness of the fifth piece, which is placed between the inner ends of each pair, and bolted thereto. Instead of being placed on edge, the transverse tie piece may be on its flat, which separates the piece under the rails still further; on any piece becoming damaged, it can be removed and replaced without the necessity of an entire new sleeper. This construction of sleeper also presents a good form to hold in the ballast when well rammed.

In Plate XXVIII., fig. 1 is a plan of rails and sleepers with a pair of wheels constructed and arranged according to this invention; fig. 2, a transverse vertical section, and fig. 3, a side elevation of the same; *a*, *a*, the rails, which are double, or twin rails; they are fixed and bolted to the sleepers *b*, *b*, *b*, without any chairs, being secured to each other by tie pieces *c*, *c*, *c*, at suitable intervals; this same tie piece *c* also serves to fix down the rails by bolts or other suitable fixings *d*, *d*, passing through or into the sleepers. The wheel W is made sufficiently broad to bear on both rails, and has the flange *f* in the middle of its breadth, and so as to be received in the space between the twin rails, as seen in fig. 2. It is proposed to make the wheels of the engine and tender only with wheels of such breadth, or in goods wagons

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having great weight to carry, and requiring the strength of support afforded by the double or twin rail. In six-wheeled engines the leading and trailing wheels may be flanged wheels, and the driving wheels without any flange, but of sufficient breadth to bear upon both parts of the twin rail; or the driving wheels may be furnished with the flange in the middle, and the leading or trailing wheels with flanges inside, as usual, but broad enough to take a bearing on the twin rail. In laying these twin rails, the joints of one rail should not be opposite to those of the other, but should break joint with each other. Fig. 4 represents a side elevation of a driving wheel, and a modification of the twin rail; and fig. 5, a transverse section of the rail and a face view of the wheel. This exhibits a twin bridge rail *g*, *g*, with the groove between for the reception of the mid flange *f*; this rail may either be bolted down on transverse sleepers at intervals or on continuous sleepers, as well understood in laying ordinary rails. Fig. 6 represents one half of a transverse section of the twin railway and wheel for ordinary carriages, showing the wheel bearing on only one half of the twin rail and flanges f^1, on the outside of the wheels and between the rails; these flanges may, however, be on the inside of the rails, as usual, but the wheels of passenger carriages need be only of sufficient breadth to bear on the inner part of the twin rail. Instead of making the engine wheels or other wheels carrying heavy weights with the flange at its mid breadth, and the parts of the twin rails at a distance apart, the twin rails are made in closer proximity to each other, and wheels are used with inside flanges of the ordinary kind, but with sufficient breadth of tread to bear on the whole breadth of rail, as represented in figs. 9, 10, 11, and 12. Fig. 9 represents two H rails, *a*, *a*, placed side by side, and fixed to a continuous plate of metal *h*, *h*, bedded on continuous sleepers; fig. 10 represents a side elevation of this combination of rails and sleepers; and fig. 11, a plan of the same; while fig. 14 represents a perspective view of the plate *h*. The raised part *i*, *i*, of this plate is rolled or drawn of a form adapted to fit between the two rails; against the sides of *i*, *i*, the rails are closely bedded, and held by means of through bolts *k*, *k*. The plate *h*, is firmly secured by nails, bolts, screws, or other fastenings to the sleepers *l*, *l*, passing through the holes in the flange of *h*, *h*. These rails are joined in manner before mentioned, so as to break joint with each other, as seen in fig. 11. This same continuous plate *h*, *h*, is also adapted for fixing a single rail, as represented in cross section, fig. 15. Instead of making the plate *h*, *h*, continuous, short pieces may be made of the same form in their cross sections as seen at figs. 9 and 15, but placed at intervals as represented at h^1, h^1, fig. 16, which is a plan of the twin rail, thereby forming supports for the rails, placed at intervals, as in the ordinary chairs; these may also be fixed to transverse instead of continuous sleepers, as before mentioned. Figs. 12 and 13 represent modifications of the twin rail, in which the two parts are placed in close contact; fig. 12 represents the rail *a*, *a*, as rolled in two parts, and with a foot or flat base or flange *m*, *m*, to rest on the sleepers, and by which it is fixed thereto; fig. 17 represents, in perspective, part of the rail; it is rolled with a continuous groove *p*, *p*, in which a small round rod of iron is placed when the two parts are bolted together, which keeps the faces of the rail in a true position with respect to each other, and prevents the one getting above the other; bolts *k*, *k*, are passed through the rails, and the junctions at the ends break joint with each other, and they may be fished at those points if required; these rails may be bedded on sleepers in the ordinary way. Fig. 13 represents a modification of the twin rail, formed somewhat like the last herein described, but so that the rails can be inverted, as in the ordinary H rail. These rails have double grooves *p*, *p*, and rods of iron *s*, *s*, for the purposes before mentioned, and are fitted and fixed in chairs *t*, *t*, much in the usual way, the chairs being wide enough to embrace the two parts of the rail and wedge *u* to tighten them therein.

The improvements in the construction and arrangement of the sleepers of railways are represented in figs. 1, 2, 3, 4, 5, 6, 7, and 8, and consist in making each transverse sleeper of five separate pieces of wood, but all of the same cross section and length. These pieces of timber *b*, *b*, *b*, *b*, should be of about half the cross section of the ordinary sleepers, so that when two are combined they present about the same substance for fixing the rails; they are of a length sufficient to allow for lapping at the points of junction *v*, *v*. The pieces *b*, *b*, are made of rectangular cross section, but broader on one side than the other, and placed on their flat sides, or on their edges, or narrowest sides, and two of the pieces are arranged under each line of the rails, and four pieces are connected by the fifth piece b^1, as seen in the several figures. The pieces *b*, *b*, *b*, *b*, may be secured by a single bolt *w*, and a dowel pin or pins *x*, *x*, as seen in figs. 1 and 2, or with two bolts *w*, *w*, as seen at figs. 3, 6, 7, and 8. Fig. 1 represents the end pieces *b*, *b*, placed on the flat, with the middle piece b^1, placed on edge, while figs. 6 and 7 represent the end pieces on edge, with the middle piece b^1 on its flat; figs. 3 and 7 represent all the pieces *b*, *b*, *b*, *b*, on edge. By this means any single piece of the sleeper can be changed, should it become decayed or damaged, without removing the whole of the sleeper, which will save considerable expense; and as all the pieces are of the same size, they may be shifted about or changed at pleasure; and the form presented by the combined pieces of wood *b*, *b*, affords great stability when well bedded in the ballast.

The novelty consists, first, in the several arrangements and constructions of the double or twin rail, herein-before described, and represented in the annexed drawings; also the placing the flanges of the wheels in the middle of their breadth, as herein-before described.

Secondly, constructing the transverse sleepers of railways of five pieces of timber, arranged as herein-before described.

CONSTRUCTION OF BREAKWATERS.

FREDERICK ROBERT AUGUSTUS GLOVER, *Patentee*, Dec. 18, 1855.

THIS invention consists, firstly, in constructing the foundations of the said structures, either with or without the other parts of the same, by so forming a framework of timber or iron, or other material, and so anchoring or fixing the same, as to collect and retain the shifting sand or material carried by the movement of the water in the particular situation in which any such structure is being erected.

Secondly, in constructing the said structures, by forming them as above set forth, and by adding lime, or cement, or concrete materials, either to assist in the retention and solidification of the said shifting sand or material, or else partly or entirely, instead of the same.

The manner in which the first part of the invention is carried out is as follows:—In order to construct foundations of breakwaters, sea walls, or other structures in situations where the invention is applicable, namely, where the natural bed of the sea or stream is composed of a shifting or moveable sand, a number of pieces of framework are to be fixed in the desired positions by means of anchors, or by weighting them with ballast; and in order to ensure a firm and sound structure, the separate pieces of framework may be bolted together. The combined framework thus set up serves gradually to collect the sands and other foreign matters held in suspension or moved about by the waves, and to enclose and retain them, the deposit continually increasing until the framework is filled and a compact mass has been produced, on which any required superstructure may be erected; and the said superstructure may be either of timber, masonry, brickwork, or any approved material, or the structure itself may in some cases be entirely completed by the use of the invention.

When necessary, in order to obtain a sufficient height of structure or of foundation for any required structure, additional framework may be fixed on to and above the first framework, the additional framework to be filled up and rendered solid as before; and should additional layers or stages of framework be required they are to be fixed on to and above each other, and filled as before, until the requisite altitude is obtained.

In Plate XXVIII., fig. 18 shows a plan of one of the frames to be placed upon the sand or bed; it is made of ordinary beams of timber, about eight inches to a foot square in thickness, connected by tie pieces *b*, *b*. Fig. 19 shows, in section, a number of frames placed one upon another. The superposed frames gradually diminish in width from bottom to top, so as to give a suitable slope or inclination to the face of the work; the distance between the cross pieces is about 60 to 40 times the thickness of the wood, which are the proportions preferred. The longitudinal beams *a* are connected by the tie pieces and rods *b*, *b*, which are arranged so that those of the first and fifth frames are united by any suitable means, and the same is the case for the second and sixth frames, and for the third and seventh frames, and so on. It will be observed that the longitudinal beams on the side Z, towards the sea, are presented in an inclined position to the action of the waves, and are supported in a notch made in the cross beams of

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the frames beneath them. The arrangement represented is adapted more particularly for the erection of a sea wall along a coast; but when more than one side is presented to the action of the waves, all the sides so presented should have the beams *a* presented in a similarly inclined position.

Although the improved structure is described as constructed so as to constitute one solid mass throughout, yet it is to be understood that the framework to be used may be made so as to leave one or more hollow chambers or spaces, which will not become filled up with the shifting sand or other natural or artificial materials; and in accordance herewith, the patentee intends the construction of sub-aqueous roadways, passages, or other tunnels, in which cases tubes of timber, or of either wrought or cast-iron; or of all of them combined, may be conveniently employed to constitute a portion of the said framework. This will be found a convenient method of forming communication across non-navigable streams, and also navigable streams or channels, where the erection of such structures will not too greatly diminish the required depth of water. An illustration of this modification of the construction is represented in fig. 20, Q being a chamber or space within the structure, which may be converted into a sub-aqueous roadway or other purpose.

Although, in the foregoing description and figures, wood has been described and represented as the material of construction more particularly employed, it is to be understood that iron or any suitable material may be substituted, the shape of the individual pieces or parts of the structure being adapted to the nature of the particular material employed.

The manner in which the second part of this invention is to be performed is as follows:—The framework is constructed in the manner before described, and to the sand or materials collected gradually added a quantity of lime, cement, or any approved concrete material, such addition being made from time to time during the process of collection, and so as to assist in and expedite the solidification of the mass. The best cement or material for the purpose is Italian puzzuolana, but good hydraulic lime may be substituted. The quantity will vary according to circumstances; but when the waves are very rough, more of the cement may be used to expedite the solidification as much as possible. Broken stone or sharp gravel may also be added with advantage, and, in fact, concrete materials may be entirely substituted instead of the natural sand which might be collected; also, blocks of beton, or artificial stone, or natural stone may be advantageously employed.

HURST'S PATENT RAILS.

THIS invention, which is now in use on the London, Tilbury, and Southend Railway, at Grays, where it has been found highly satisfactory, is intended, as stated in the specification of the patent, to render the whole line of rail, though composed of many different lengths as usual, one continuous and complete rail, as it were, and allow of the sleepers of the kind now in use being placed at a uniform distance apart.

FIG. 1.

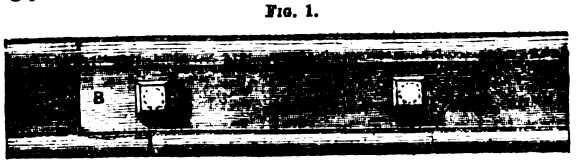

Fig 2

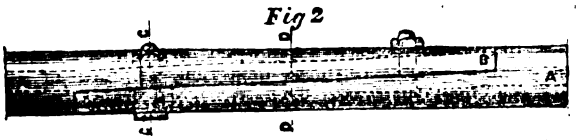

Fig 3 Fig 4 Fig 5

The invention can be applied to double and single faced rails, and consists in giving a modified "scarf joint" form to the ends of each length of rail; that is, a scarf-joint form with the addition of a tongue, which is the extreme projection of the rail, and which tongue, when the ends of two lengths are properly brought together, fits in the channel of the rail between the flanges, or in one form rests upon the lower flange only. The lengths of rails are to be kept in position by the usual chairs and keys, and in addition, or substitution for them, there may be square or other suitable rivets or bolts passing through both lengths of rails at the joint, which will not only prevent the vertical working now found to occur, but will tend to preclude accidents occurring from the joints getting foul.

Fig 6 Fig 7 Fig 8

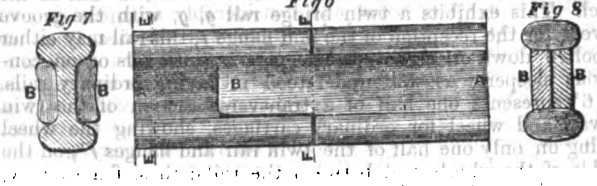

Fig 9

Fig 10

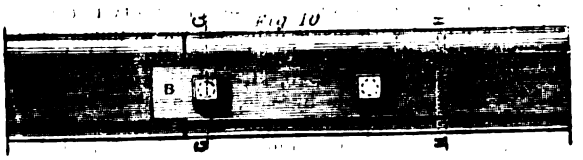

Fig 11

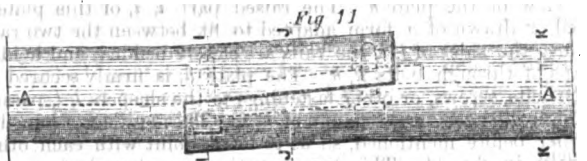

Fig 12 Fig 13 Fig 14

The engravings illustrate different applications of the invention. Fig. 1, is a side elevation; fig. 2, plan; fig. 3, section on the line C C; fig. 4, section on the line D D; fig. 5, end view of rail; fig. 6, side elevation; fig. 7, end view; fig. 8, section on the line F F; fig. 9, plan with tongues in section; fig. 10, side elevation, showing the application of the patent to the bridge rail; fig. 11, plan; fig. 12, section on the line I I; fig. 13, section on the line J J; fig. 14, section on the line K K. In the plan views, the dark diagonal lines denote the "scarf-joint" line; and in the elevations the dark lines B, denote the tongue or tongue-piece; the letters A, A, are placed upon that part of the rail that is of the form commonly used. As to the construction of the joint, the inventor states that it may be made by cutting away the flanges to the extent required, re-beating the end of the rail, and placing it in a die, in which it is pressed to the form required; or the steam hammer or rolls may be adapted for this purpose.

The Weston-super-Mare Improvement Act Commissioners wish to receive plans and specifications for the erection of a new Town-hall over their market-place, the cost of such building not to exceed 2000*l*. A plan of the ground, if required, may be obtained by application to the clerk. The drawer of the plan approved by the commissioners will receive fifteen guineas, such plan to be the property of the said commissioners. Plans must be sent to William Smith, No. 5, South Parade, Weston-super-Mare, on or before the 8th inst.

A premium of 100*l*. will be given by the Committee of the Canal Association to the author of the best essay on the present condition and future prospects of canals and canal conveyance, with suggestions as to the points to which attention, with a view to improvement, should be principally directed. The essay must be sent in on or before the 31st of December, 1856, to Thomas Wilson, Hon. Sec., Aire and Calder Navigation Office, from whom further particulars may be had on application.

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REVIEWS.

Lectures on Church Building, with some Practical Remarks on Bells and Clocks. By E. B. Denison, M.A. Second Edition, re-written and greatly enlarged. London: Bell and Daldy. 1856.

It may be taken as some evidence that the opinions put forth by Mr. Denison, crude though many of them be, find either favour or interest in the eyes of the community, since the original impression of this work is now out of print, although only recently published; and, a second being called for, the author has taken the occasion to revise and considerably augment its contents. As may be supposed, he in no way flinches from his former avowals, which he seeks more convincingly to maintain, while, at the same time, a better tone of feeling is evident, and more conciliating modes of expression are adopted, which will go farther in gaining and securing adherents than the self-satisfied dogmatical reasoning which pervaded the former chapters.

In our former notice (April 1856) we took occasion to glean from the contents enough to put our readers in possession of the general ideas of the author, as well as some of their more peculiar phases, and mentioned some to which no sincere and self-respecting architect could ever subscribe. Still, Mr. Denison, as a man of quick perception and intelligent observation, standing quite aloof moreover from the circle of the profession, is better entitled than the majority of amateur writers to a candid hearing. Avoiding, therefore, as much as possible the points previously touched upon, it will be worth while again to resume the thread of the discussion.

As regards church building at least, the classical or Renaissance style is, according to our author, dead and extinct, in spite of all that Mr. Tite and a small section of the profession would urge; and that is the very reason, he says, why we should pay more attention to mediæval principles than we have hitherto done, if we intend to carry them farther, or even to avoid reaction and retrogression. For, great and rapid as has been the improvement, "it must be admitted that there has not been a single modern church yet erected, much less any other kind of building calling itself Gothic, which any person of experience could for a moment suppose to have been built in mediæval times. Long before you have satisfied yourselves where the mistakes are, you see at a glance, in nine cases out of ten, that the building is full of them, and that it is in short one great mistake (!); and even the tenth is only so much better, that it takes longer to discover where the faults are, though you see in a moment that somehow or other it is very far from being the 'real thing.'" What a pity it is that so discerning a writer can put his thoughts on paper only, instead of rearing them in imperishable materials! Really, if architects could be terrified by sweeping censures, Mr. Denison would be the man to inflict them. But, happily, there are some few, and the number is increasing, who love their work for its own sake, who conscientiously investigate latent principles, and delight to see them germinate afresh in soil akin to that of days gone by, days on which our author casts his longing, lingering look; and we have good reason to be assured, that as such efforts become rightly comprehended and encouraged, a better state of things will ensue, beneficial alike to art, artists, and the community at large.

The question of window tracery and mullion detail is even more fully treated than in the former book, and the number of old authorities consulted appears to be very great. One axiom which Mr. Denison inculcates from the result of his observations is, that "no mullion ought to be much less than one-third of the width of the adjacent light." The lights of the small windows at Guisborough Abbey are, it appears, *exactly* three times the width of the mullions, and this is but one example out of many. "Where there are more lights than three, and therefore two or more classes of mullions are required, the larger ones must be considerably more than this," "and in all cases it appears that the depth from back to front ought to be at least twice the width or thickness from side to side." Thin mullions are undoubtedly one of the great defects in modern Gothic: the plea of cheapness sometimes is all-prevailing, but, where possible, stonework should be made, apparently as well as in truth, useful in construction, according to the position it occupies. The objection which is sometimes raised to bold, sensible-looking mullions, that they too much obstruct the light, is easily overcome by increasing the openings of the window itself, which will in nine cases out of ten be in itself an advantage.—Mr. Denison goes on to urge that glazing should always be set deeply in the walls, a point to which we before alluded approvingly.

Speaking of the ground plans of churches under different arrangements, we find the following as to Doncaster New Church: —"I was asked the other day how I justify the building of a cross church here at all, and why we do not get the space we want by other means than building transepts, in which some of the congregation must be behind the large central pillars. The question is not very difficult to answer. After you have got a nave as long as an ordinary preacher can be heard in, and as broad as it ought to be in proportion, in which direction are you to extend the building if it is still too small for the congregation you want to provide for? Clearly you would not advocate an extension of the chancel, for there the people would be in a worse place for hearing in a large church, than in transepts. You must, therefore, either make the nave too large for the whole of it to be used by the congregation, or you must spoil the church by returning to the abomination of galleries, or you must build transepts."

Mr. Denison then proceeds to give his notions as to when central towers are advisable, and when they are an objectionable arrangement, and extends his subject in treating of spires and spire growth. He advocates small spire lights or lucarnes, and banded horizontal diaper work (as at Salisbury) for enrichments. He also approves of croketting spires, thus differing from the majority of architects.

On *Bell-hanging*, Mr. Denison thus delivers himself—

"In order that a peal of bells may produce the proper effect, the tower should be large enough to let the bell-frame stand at least 2 feet from the wall all round; and the bells should neither be below the bottom of the windows when they are telling (*i. e.* swinging slowly with their mouths downwards), nor above the top when they are ringing in full swing with their mouths upwards; and the windows should be large, and the louvres wide apart and not much inclined, so as to keep in the sound as little as possible."

Mr. Ruskin also abuses close louvres on architectural grounds, and notices the grand effect of the large wide ones in many foreign churches. Ours are generally made as if the bells were liable to catch cold and lose their voices if they got wet, whereas bell-metal is perfectly indifferent to it; and, if the bell-chamber floor is covered with lead or zinc outside the bell-frame, and drained into a pipe in one corner, no rain that can come in through louvres will ever do harm either to the bell-frame or the floors underneath. On this question of bell-hanging and ringing, into which Mr. Denison goes at some length, he may be considered an authority, from the attention he has paid to these matters.

Though the walls of a tower sway when the bells are rung, it does not necessarily imply danger to the fabric. Stone, like everything else, is elastic to a certain degree; and many a tower has gone on vibrating for centuries, without being any the worse for it. Indeed, we know there are few towers that do not shake a little when the bells are rung: it is simply a question of degree how far the ringing is safe. When it is not, it must be stopped and the bells merely tolled, or else rung by pulling the clappers only.

Another care in fixing bells should be, that the bell-frame does not touch the walls. Many a tower has been seriously damaged by parish carpenters making the frame "steady," by wedging it against the wall. It is important, too, that sufficient height be left between the belfry-floor and the bell-chamber to admit of two distinct ceilings (the heights depending on the size of the bell-wheels); the lowest should not be less than 16 feet from the floor for a small peal of bells, and 20 feet for a large one.

The scientific construction of the frames, and the proper mechanical system of hanging, is subsequently fully explained, and the reasons given with great clearness (it will be remembered that the whole question was not made the subject of successive debates at the Institute of British Architects during the past session); and the work concludes with a like disquisition on church clocks and their management.

Altogether, Mr. Denison's book is a very readable one, and, setting aside the most objectionable dogmatism it too often exhibits, will be studied with profit by all who are interested in the multifarious topics of which it treats.

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ARCHITECTURAL IMPROVEMENTS OF LONDON.
No. V.

Before taking leave of these edifices recently erected in the City, we may name with some satisfaction the street building (now nearly finished) on the western side of Mark-lane, called the "Mark-lane Chambers," designed by Mr. Randall. This structure, with some novelties of design and arrangement, presents a favourable example of the combination of the Italian elements of composition, without descending to slavish copyism. The elevation is not of one uniform height throughout, the centre mass being carried to the altitude of 62 feet, whilst the portions at each side are 53 feet high respectively. The Doric order has been mainly adopted in the design. The first-floor story of the building is composed of coupled pilasters attached to piers between the windows, and over the entrance doorways (two in number) are columns surmounted by the usual entablature, over which is open balustrading. This entablature, instead of being carried right across the elevation in one uninterrupted line, is broken over the piers between the windows, as well as over the doorways, which produces an agreeable and varied outline, with an extra amount of light and shade. Above the level of the first floor, the usual rigid rule of Palladio, Sansovino, and other eminent Italian architects, has been abandoned: the principal cornice, instead of being inserted at the eaves of the roof, is run across the elevation over the second-pair windows. Another departure also from ordinary rule consists in the second-pair windows having semicircular heads, the soffits and jambs of which are coved. These windows are separated from each other by piers, on the upper portions of which are long, narrow trusses, highly embellished with carving of fruit and flowers suspended from the heads of lions and dolphins. The upper portion of the elevation is appropriate and elegant, and the entire façade may be pronounced a decided advance upon the usual direct copyism which prevails to so great an extent at the present time. The staircases are constructed of Portland stone, on what is technically termed the geometric principle; the area of the larger one is 19 feet by 14 ft. 6 in., and of the smaller 14 ft. 6 in. by 10 feet. The steps of the former project 4 ft. 9 in. from the wall; and those of the latter, 2 ft. 9 in. The materials employed for the exterior elevation are Portland stone up to the first-floor, and Caen stone for all the upper portion of the façade. The works have been executed by Messrs. Lucas Brothers.

Leaving our architectural improvements in the City, to notice others at the west end of the metropolis, we shall first mention those upon which the largest amount of capital has been expended, omitting, however, one upon which so much has been wasted without satisfactory result—Buckingham Palace, upon which has been spent, during the last thirty years, an amount of money that would have produced a building rivalling either the Louvre or the palace of the Tuileries. And after the employment of three architects upon it, the Prince Consort, and several German and Italian professors—what has been produced? A structure which must ever remain a national disgrace.

We turn from this gross blunder to some of those princely palaces erected within the last twenty years in Pall-mall, St. James's-street, and Regent-street. If some of these magnificent edifices do not possess much originality of conception, if they do not embody the *beau ideal* of architectural perfection, at any rate it is hoped they will bring about a new era, in which our professors will reject the puerilities of such men as Adams, Nash, and others, and base their studies upon the works of those great Italian masters who laid the foundation of that style which appears destined again to have a triumphant revival. In reference to this subject, Mr. Digby Wyatt justly observes, that we have seen revivals, Greek and Mediæval, "but the mediocrity of their advocates is evinced by the want of individuality in their works. To imitate the externals of their models has been their highest aspiration—their only aim." We want, and must have, something beyond this, if the dignity of British architectural art is to be maintained. More has been done previously—Inigo Jones, Wren, Vanbrugh, have done more. We do not aver that their works are perfection; far from it; but we do say that there is an unmistakeable *individuality* about their productions that cannot remain unrecognised. We fail to distinguish this individuality in our modern works. Mr. Smirke's Carlton Club-house is a mere transcript from Sansovino's celebrated Library at Venice;—Sir C. Barry's Houses of Parliament is a monster enlargement of the features of Henry the Seventh's Chapel, with considerably more monotony;—Sansovino is again repeated by Messrs. Gingell and Lysaght at Bristol;—and so on to the end of the chapter. Would that a spark of the "celestial fire" of originality would possess some of our professors of the art!—then, and not until then, we fear, will anything be produced which shall range beyond mediocrity, and rescue us from our present degradation.

In commenting upon the architectural improvements of the west end, we may remark with gratification, that great advances have been made in the art within the last half-century, as some of the club-houses will prove. We may first select the "Reform," by Sir Charles Barry. That Sir Charles is a great—a very great artist, no one without prejudice will deny, that he has a fine eye for the picturesque is undoubted; and no one will have the hardihood to affirm that his design for the Houses of Parliament was not immeasurably superior to all others in its general outline "against the sky." Unfortunately, however, this is in a great measure marred in execution by its feeble and excessive multiplicity of parts, its trifling details, and its want of bold projective buttresses required to produce depth and shadow. The Reform club-house, however, although far from perfect, is a very great advance upon previous essays in the Italian style, as illustrated by the painted compo-works of Nash in some structures for similar purposes erected in and about Waterloo-place; but yet, if Barry had to design another from the same materials as that of the "Reform," we are persuaded that he would make very considerable improvement upon it. It is generally admitted that one of the great secrets of architectural designing consists in the judicious distribution of plain and enriched surfaces, so that there may be no undue baldness in one portion, nor an excess of enrichment or moulded work in another. In this peculiar quality Sir Charles Barry sometimes fails; he has done so in the present instance, for no one we think will doubt that there is too much plain wall surface between the top of the first-floor windows and the string-course above, which serves as a continuous ornamented sill for the upper windows. Looked at, however, as a whole, this club-house is a truly noble pile, and it is a pleasant task to advert to some of its undoubted beauties. The range of windows at the first-floor level are most successfully treated, having Ionic columns projected from their jambs, with the usual entablature, and pediments above, underneath the corona of which are plain modillions, simple and highly effective. These windows have open balustrading at their sills with pedestals at either side, and continued panelled work between each. Underneath is an enriched string-course, with mouldings broken round the sills supported by moulded trusses. The entrance doorway is in the exact centre of the façade, and is admirably proportioned, with a highly judicious distribution of enrichment in its details; it is Ionic, with modillions in its cornice, which is supported at each side by elegant moulded trusses, across the faces of which are suspended swags of flowers from the pateræ on the centre of the volutes. The principal cornice, at the eaves is very elaborate in its enrichments, but is somewhat too large in its proportions. The surfaces of the walls between the windows throughout the whole building are perfectly plain, no chinellings or rustic work being employed, except at the quoins, which are chamfered. The boundary wall next the foot-pavement is very elegant in its composition, being composed of pillars with well designed candelabra upon them. Between the pillars are square balusters and the usual coping.

The next block of building to the west in Pall-mall, on the same line as Sir Charles Barry's structure, is the Carlton club-house, designed by Mr. Sidney Smirke—if the term designed may be applied, it being a mere adaptation from its Italian original, with some omissions and variations which are the reverse of improvements. It will be remembered by those of our readers who have seen the celebrated Bibliotheca of Santa Marco, at Venice, from whence Mr. Smirke's production is taken, that it consists of two stories only, the lower being Doric and the upper Ionic. In the lower story Mr. Smirke has very injudiciously stripped the cornice of its mutules, and thereby rendered it tame in the extreme; he has also omitted the moulded archivolts of the lower windows and the sculptured figures in their spandrels, by which the harmony and due balance of parts in the whole structure are destroyed, and the lower order of the composition rendered poor and contemptible. The entrance is effected by a portico projected from the centre of the façade in Pall-Mall, attached to the main walls by the principal lower cornice breaking all round it and connecting the whole. This portico is

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supported by coupled columns at each side, with corresponding pilasters attached to the walls. One peculiarity of this building is, that its columns and pilasters are constructed of red granite, highly polished, which do not at all improve the effect of the edifice, but rather detract from its simplicity by their startling contrast of colour. The swags of fruit and flowers, held by boys on the frieze of the upper cornice are admirably executed. As a whole, we cannot conscientiously pronounce the structure to be equal to its great prototype, nor yet so successful as the adaptation from the same original to the new Bank recently erected at Bristol. The open balusters inserted in the parapets over the upper cornice are much too small—trifling in the extreme, and out of all proportion with the other details of the edifice.

WHITEWASH, AND THE MODE OF REMOVING IT.

GREAT uncertainty and difficulty are often expressed as to the readiest and least injurious method of removing whitewash, in churches especially, where it frequently serves but to conceal some wall painting executed probably in distemper or some such other frail medium. The Ecclesiological Society recommend "Manchester Card,"—a sort of wire brush used in the wool manufactories for combing wool,—and the refuse, after it is done with in the manufactories, does very well for *scraping* off whitewash from a flat wall. It is to be had very cheap in the manufacturing districts, and is supplied wholesale and retail by Mr. French, of Bolton le Moors, Lancashire.

The objection to this *scraping* process by a wire brush is, that it scrapes off the fine edge of any mouldings or carved work, and it should never be used except for the plain flat surface of the wall, and then it scrapes off any painting there may be under the whitewash.

A better process appears to be, to wet the whitewash thoroughly, let the wet sink into it well for some time, and while it is between wet and dry, peel it off with an ivory or bone paper-knife: it will generally come off in large flakes and in successive layers, so that any painting on the plaster itself may be preserved. This method requires very little labour or trouble—the only thing necessary is care; and as either ivory or bone is softer than most kinds of stone, it is not easy to do any mischief, as the tool will break before the stone will give way to it: for this reason no iron or metal tool should be used. One end of this paper-knife, or folding-stick, as the bookbinders call it, should be cut to a point, and used to pick out the whitewash from any carved work. Miss Baker, of Northampton, a few years since, cleared out the whole of the beautiful Norman Capitals in St. Peter's Church, in that town, with her own hands; and any trustworthy person, with a sufficient amount of patience, is capable of doing the like.

NOTES OF THE MONTH.

London and Middlesex Archæological Society.—The first annual general meeting of this society was held on July 24th, at the rooms of the Architectural Museum, Canon-row, Westminster, and was presided over by Lord Robert Grosvenor, M.P., who occupied the chair in place of Lord Londesborough. The report of the past year was read, the council for the ensuing year arranged, and sundry votes passed of the usual complimentary character. Meetings of the members and friends of this society are held periodically in London, and occasionally at different places in Middlesex; and their transactions, including original papers and communications, are published from time to time. The number of members enrolled is now 250, of whom fifteen are life subscribers, and the audited account shows a good balance in hand. At the conclusion of the business meeting, the company adjourned to Westminster Abbey, which was courteously thrown open for their inspection by the sub-dean, Lord John Thynne; and every one was thus enabled leisurely to traverse that magnificent building from the crypt to roof. In the course of this examination, which occupied several hours, instructive lectures were delivered by Mr. Scott, architect to the Abbey, on its *material* features and history, and by the Rev. C. Boutell, who undertook more particularly the *monumental* department.——At the evening meeting, held also at Canon-row, the chair was taken by the Rev. Thomas Hugo, F.S.A., a member of the council, when Dr. Bell read an interesting paper on the heraldic badges upon the royal monuments, and was followed by the chairman, who gave a graphic sketch of the early history of the Abbey, and the original structures which preceded the existing building; these he intended as an introduction to Mr. Scott's remarks, which commenced from the foundation of the present edifice; after which some further observations on the subject were made by the Rev. C. Boutell, and by Mr. Scott. Finally, a supplementary paper was read by Mr. G. B. Webb, Hon. Sec., describing a stone coffin and some Roman pottery, lately discovered at Bow, a specimen of the latter —a patera of red earthenware—being exhibited to the meeting. This closed the proceedings of an auspicious day.

St. Michael's Church, Cornhill.—In the course of excavations now in progress to prepare for a new entrance to this church from Cornhill, the workmen have disclosed parts of two old walls, running parallel in a north and south direction, about ten feet apart. They are of considerable thickness, one especially, which is undoubtedly Roman, and is most substantially constructed in the customary manner. The layers of tiles are large and thick, and of that peculiarly deep red colour which distinguishes this kind of material. A few fragments of pottery have been dug up, but nothing perfect. The other wall, to the westward, is not so old, being built mostly of rough rubble, intermixed with pieces of Roman work, showing that the spot had been previously disturbed. At about nine feet below the street paving there is a black stratum of charred wood a few inches deep, which evidently indicates the ravages of the great fire of London, and the ground level at that period. It will be remembered that, till a year or two since, some venerable-looking shops occupied the site, through one of which was the door into the church; but, circumstances permitting, they were then taken down to throw open the full elevation of Wren's noble tower.

Old London.—A prospectus was some time ago issued by Mr. Roach Smith, the antiquary, for a new work on Roman London. A numerous subscription list has been obtained; but while intelligent persons from all parts of the country, including the Mayor and Corporation of Manchester, are among the subscribers, strangely enough, not a single person attached to the London Corporation has as yet offered to support this highly-interesting publication!

St. Petersburgh.—This, the latest addition to Mr. Burford's panoramas, is of a more than usually architectural character. The supposed station point of the spectator is on the Observatory, which the city entirely surrounds. The clear-flowing Neva is seen meandering at the foot, crossed at intervals by bridges; one of these is of boats, and another, of comparatively recent erection, of iron. Along the water's edge are ranged the principal buildings, and foremost, the imperial Winter-palace, an immense building, three stories in height throughout, of classic design, and presenting an unbroken mass of simple grandeur. This same architectural character pervades the majority of the public buildings and the residences of the ambassadors and chief merchants. Close to the palace is the Admiralty, with its spacious dockyard; the design of its main entrances is very unmeaning and heavy looking. Round the margin of the island on which the Observatory stands are erected at intervals rostral columns, serving to support beacons for lighting; these have a peculiar and picturesque effect. In the distance, overtopping the houses, a prominent object is the church of St. Isaac, so noted for its lofty porphyry columns, its dome, and other magnificent features. Dotting about in various directions other domes are discernible, several of which belong to convents, and they are studded with gold and silver stars. Besides the structures we have mentioned, many others of considerable pretension arrest the eye in wandering over the view, such as the Exchange, Citadel, Senate-house, Church of the Transfiguration, the Academy of Arts and Sciences, &c., so that altogether an architectural visit to this panorama may be made both pleasantly and profitably.

The New Smoke Act.—This Act will not take effect till the 1st of January next, in order to give parties time to abate the nuisance. Glass and pottery works, now exempted, are to come under the Act of 1853; and also steam vessels plying between London-bridge and the Nore Light.

Illustrations of the Architecture and Arts of Italy.—This most interesting subject, which will fill up another link in the illustration of national archæology, is preparing for publication in a serial form, by Mr. George Goldie, architect, of the firm of Hadfield, Weightman, and Goldie, of Sheffield, architects to the Duke of Norfolk. The work, which is intended to consist of 80 quarto plates, will depict the architecture of mediæval Italy, and those arts and craftmanships which were associated with it in such exquisite harmony. The whole of the drawings, we understand, were made on the spot during the years 1850 and 1851, merely for private study and inquiry, and without any view to their publication, and it is only in compliance with the solicitations of many archæological and architectural students and professors that the work will appear. We have seen about forty of the subjects, and to us they appear to possess the greatest interest, whether considered as to taste, invention, or workmanship, and are well calculated to prove most suggestive to those who wish to adapt their designs to examples which display pure genius and sound judgment. The plates to be contained in this work, elucidated by letter-press, will embrace a vast field of variety, exhibiting much of the interior, exterior, and detailed ecclesiastical, monastic, and domestic architecture existing throughout Italy. The painted glass, rare metal work, inlaid and incised work, monumental sculpture, mosaic and diaper work, decorative painting, ornament, needlework, and encaustic tiles, are to be executed in lithography, and those that demand the effective aid of colour and gold to give resemblance to the real subjects will receive it; we believe a large portion of the plates must be thus produced. It is intended to publish the first number in January next; but further details no doubt will be given in the prospectus of the publishers, Messrs. Bell and Daldy, which is about to appear.

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The Collegiate Church of Edington, Wilts.—This church, so remarkable and interesting from its connection with the history of the transitional change from the late-decorated to the Early Perpendicular style of Gothic architecture, is preparing for publication by subscription, in imperial folio, from the drawings of Mr. V. W. Arnold, architect, under the patronage of the Lord Bishop of Salisbury. The drawings intended to illustrate the work, no fewer than seventeen in number, representing the whole building, have been submitted to us. Among the series of subjects there are several perspective views of the interior and exterior, with plans, elevations, and sections; besides these, the whole of the rich and varied detail will occupy several plates. Knowing the curiosity and interest that exists towards this ancient edifice; we feel bound to state that we have seldom seen so nice and careful a set of drawings; indeed, we may say that every attention has been bestowed to render them with clearness and fidelity, and we anticipate that whenever the work appears it will be esteemed both by the professional man and the ecclesiologist, as a valuable addition to existing architectural works. A historical detail of the edifice will accompany the plates.

Gloucestershire.—The recent visit of the British Archæological Society to Winchcombe and its neighbourhood suggests a brief reference to the architectural ruins in that once famous locality. Winchcombe was anciently the site of a castle, and of a mitred abbey for 300 Benedictine monks, but every vestige of those buildings has been levelled with the dust, and the places where they stood are imperfectly remembered. The present church, dedicated to St. Peter, was begun in the reign of Henry VI., by the abbot, William Winchcombe, who completed only a portion, the rest being finished by general subscription, assisted by the munificence of Ralph Boteler, Lord Sudeley. Besides the historical interest attached to the building it has few claims to attention; for, though large and having a noble western tower, there is now too little of the architectural remaining to need special notice.——Hayles Abbey, a mile or two distant, was founded for Cistercian monks about the year 1236, and the buildings were finished in the most magnificent style of the age at an expense of 10,000 marks, and the king himself (Henry III.) was present at its dedication. It appears from the ruins, that the buildings formed a quadrangle, with a cloister, including an area of about forty yards square. The south-west angle contained the abbot's lodgings; and part of the entrance tower still remains. This is embattled, and contained a great chamber with large bow windows. The other part of the abbot's lodgings (which are said to have been rebuilt shortly before the dissolution) extended over the cloisters; some broken arches of the latter, in the lancet form, with ornaments of trefoils, are yet standing, as well as the conventual barn, and various offices, now inhabited as cottages.——Sudeley Castle is about a quarter of a mile south-east from Winchcombe, and appears now more like a castellated mansion than a baronial fortress. This building was erected by Ralph Lord Boteler before referred to, "a famous man of warre," as Leland says; and part of the windows here are said to have been glazed with beryl! Sudeley afterwards fell into the hands of the crown, and so continued till the reign of Edward VI., when it was granted to Sir Thomas Seymour, who, having restored its neglected buildings, retired hither with Catherine Parr, the queen dowager, who had honoured him with her hand. This lady here died, and was buried in the chapel; her effigy being sculptured in alabaster. The tomb had been wholly destroyed (doubtless by the republicans during the civil wars, when the rest of the buildings suffered so much), but her grave was opened in 1782, and, the body being taken up, her name and titles were found marked upon the cere-cloth in which it was enclosed. The extent of the castle and its lofty towers, with the rich architecture of the hall, in various fragments, indicate the magnificence celebrated by Leland and by Fuller, who, in his quaint phraseology, calls it "of subjects' castles, the most handsome habitation; and of subjects' habitations, the strongest castle." Part of the ruins have been rebuilt as a residence, and the chapel is now in course of thorough restoration in a worthy style, including a new panelled roof, richly carved and bossed, screen, stall seats, and a handsome tile pavement.

Bristol Cathedral.—A memorial window has lately been finished and put up in the Elder Lady Chapel, on the north side, by a few friends of the late Canon Harvey. There are seven medallions, set in the cusp-foliage of the period, on very light glass, after the manner of the well-known "five sisters" of York, and they portray some of the chief miracles of our Lord. Beneath is an appropriate inscription.

Faversham Church, Kent.—It is intended shortly to recommence operations at this fabric, originally an unsightly one of the Batty-Langley age and style; but now, under the skilful hands of Mr. Scott, becoming a really respectable Gothic church. The exterior walls of the nave, aisles, and transepts are already completed, but internally all its classic features as yet remain, even to the fittings, with the exception of the font, which is new and of the most elaborate description in marble and alabaster. The part next proposed to be undertaken is the tower and spire, at present exhibiting a meagre, brick elevation, but which is to be made more substantial and good-looking by a strong casing of flint with Bath stone dressings, and to be duly enriched with suitable architectural details. An extra thickness, again, is given to the lower stage, in order to receive a deeply-recessed shafted doorway, with its gabled head, and to give proper effect to the adjoining buttresses, which will have niches inserted, thus forming a very satisfactory *ensemble*. Above, these buttresses become octagonal, and have shafts at the angles, and they terminate above the parapet in pinnacles of the same form, richly crocketted. The belfry windows are adaptations, of three lights each, and having a connecting band of quatrefoils all round the tower at the level of their springing line. The spire is of curious mechanical construction, and modelled on the plans of Wren's St. Dunstan's-in-the-East, and St. Nicholas, Newcastle, inasmuch as it is a slender work, rising out of four flying buttresses. The height of this steeple altogether is about 135 feet, of which the spire above the parapet measures 60. The entrance lobby under the tower will have a groined ceiling springing from shafts, with an additional ribbed arch leading into the church.

Woolwich.—At Woolwich a new garrison chapel is about to be commenced, from the designs of Mr. G. G. Scott. It will be situate immediately adjoining some of the principal offices of the dockyard, and as a good architectural character is to be imparted to it, it will greatly relieve the dull monotony of the plain homely buildings around. The style chosen is the Early-Decorated, and the area is divided into a nave of five bays with aisles, and a chancel terminated semicircularly. The dimensions are as follows:—length of nave in the clear, 90 ft.; of the apse or chancel, 32 ft.; width of nave, 32 ft.; of aisles, 11 ft. 6 in. There will be a gallery round three sides, to afford as much accommodation as possible. Externally, the chief feature in the design is the chancel, which is shafted and arcaded throughout, with windows piercing occasionally (the same idea is also adopted within). Connected with the chancel arch is the bell turret, of stone, octagonal, and standing relieved from the roofs. Buttresses are introduced along the flank elevations to correspond with the divisions of the nave, and in each bay are two single-light windows above the string, and a like number, differently treated, below it; dwarf buttresses are also here added, centrally. The roofing to aisles is not on the horizontal *eaves* plan, but gabled between every pair of buttresses,—a custom frequent on the continent. We have not heard the amount contemplated to be expended.

Nuthurst, Sussex.—The ancient parish church of Nuthurst, near Horsham, has been partially restored, and entirely reseated with oak. A new pulpit and desk, by the Wood-carving Company, has been placed under the chancel arch, on the north side, and the sacrarium in the chancel paved with Minton's encaustic tiles. The church is now about to be considerably enlarged westwards, and a turret, containing three bells, surmounted by a spire covered with oak shingles, is to be placed upon the roof, with the main timbers springing from stone shafts inside.

Braintree Cemetery.—This cemetery was consecrated, on the 11th ult., by the Bishop of Rochester. It is in extent three and a quarter acres, and is completely arranged with chapels, lodge, boundary fences, &c. The chapels are in the centre of the ground, and both comprised under one roof; the size of each is 34 feet by 24 feet in the transepts, the nave and chancel being 15 feet wide. The style adopted is Gothic, and is executed in red brick, with Caen stone dressings, which materials are also employed in the lodge and boundary walls. There is attached to the chapel a stone turret 60 feet high. Internally the two buildings are divided by a wall, the main entrances being on each side. The plan thus forms a double cross, which is found to be well adapted for buildings of this class, the spaces on each side of the inner transepts being filled up as vestries. The total cost is about 3000*l.*, thus distributed:—Chapels, lodge, and gates, 1300*l.*; for laying out and draining, say 850*l.*; purchase of ground and sundry expenses, about 850*l.* The architect is Mr. J. Johnson, of Bury St. Edmunds; and the contractor, Mr. Brown, of Bocking, Essex.

PUBLIC BUILDINGS IN THE PROVINCES.

Hanley and Shelton School of Art.—An exhibition which has been started at Hanley was lately opened with a public *conversazione*. The collection embraces especially many rare and various specimens of art manufacture, &c. Among the contributors will be found several distinguished names; thus there are articles from her Majesty's private collection, from the Museum of Ornamental Art, at Marlborough House; also a choice assortment of water-colour drawings, lent by J. L. Ricardo, Esq., M.P., with additions in illustration of local manufactures, &c. It possesses also 100 coloured engravings of Russian antiquities, ivory castings, electro-shields, &c.

Stourbridge.—The first stone of a mechanics' institution for this place was laid on the 18th ult., by Lord Lyttleton.

Gloucester.—The movement in favour of public baths is still gaining ground, as it should do. An institution of this kind is immediately to be commenced at Gloucester.

Eye.—A new Corn Exchange and Town Hall are in progress at Eye, where suitable mercantile conveniences have long been wanted. The first stone was laid by the mayor, on August 18th. Of the design itself we have heard but little; it has been prepared, however, by Mr. E. B. Lamb, of London, and is to be carried out by Mr. R. Hawkins, of Monks Eleigh, Suffolk.

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OBITUARY.

On the 14th ult., at Clapham, the Rev. William Buckland, D.D., Dean of Westminster, aged 72; for many years intimately identified with the progress of geological and mineralogical science in this country, and one of those to whose exertions we are chiefly indebted for the foundation of the British Association for the Advancement of Science. Unhappily, in the year 1850, his brain gave way under the excessive activity imposed upon it during a long life devoted to science; and, since that time, has never sufficiently recovered to permit of attention to his favourite pursuits.

August 17th, in London, James Hann, aged 58, many years Mathematical master of King's College School. He was an Associate of the Institution of Civil Engineers.

On the 13th ult., Mr. James Bremner, civil engineer and ship-builder, at Pulteneytown, Wick.

Recently, at Florence, Pierre Freccia, a Piedmontese sculptor, justly celebrated for his "Psyche," and his model of the monument of Christopher Columbus.

NEW PATENTS.

PROVISIONAL PROTECTIONS GRANTED UNDER THE PATENT LAWS AMENDMENT ACT.

Dated June 20.

1454. A. Sands, Manchester—Improvements in apparatus for signalling and for saving life and property at sea, part of which is applicable to signalling on land

Dated June 24.

1482. J. Harrison, Blackburn, and C. Gelderd, Lowmoor, Clitheroe—Improvements in looms for weaving

Dated June 26.

1504. D. White, Winchester-place, Clerkenwell—Improved apparatus for the more perfect combustion of gases, for preventing their escape, and the unnecessary radiation of heat therefrom

Dated July 2.

1549. J. H. Johnson, Lincoln's-inn-fields—Improvements in the manufacture of cast steel. (Communication from J. Jackson and Son, St. Seurin, France)
1550. J. H. Van Hengel, Chaussée de Malines, Belgium—Improvements in apparatus for raising and lowering bodies in mines
1551. P. Heyns, Poplar, Middlesex—Improvements in axles, boxes, and wheels for carriages
1552. J. Fleming, jun., Newlands-fields, Renfrew—Improvements in bleaching, washing, cleansing, and preparing textile fabrics and materials
1553. W. F. Spittle, Birmingham—An improvement or improvements in braiding or plaiting machinery
1554. E. Green, Birmingham—Improvements in the manufacture of buttons
1555. W. Humber, Dowgate-hill—Improvements in the permanent way of railways
1556. A. Nouriseon, Rue des Petites Ecuries, Paris—Improvements in drying and burning bricks and other articles of clay
1557. T. E. Marrais, Ferrières la Verrerie, Orne, France—Improvements in railway signals
1558. J. Williamson and J. C. Stevenson, South Shields—Improvements in evaporating saline solutions
1559. W. H. Hubbard, Hemus-terrace, King's-road, Chelsea—Improvements in the manufacture of articles for lighting domestic and other fires
1560. W. Burnett, Margaret-street—Improvements in electric telegraphs, and in apparatuses employed therein
1561. A. V. Newton, Chancery-lane—Improvements in air engines (Communication)
1562. A. V. Newton, Chancery-lane—Improvements in machinery for manufacturing rope or cordage. (Communication)

Dated July 4.

1572. R. L. Howard, Whitecross-street—Improvements in valves for regulating the flow of fluids
1574. L. Cornides, Trafalgar-square, Charing-cross—Improvements in cementing and uniting together plain or ornamented surfaces of glass, or in uniting surfaces of glass to surfaces of metal or other material

Dated July 8.

1600. G. B. Watkins, Godmanchester—Improved apparatus for obtaining infusions or extracts from various substances
1601. W. Youtman, Southampton—Improvements in valves and plugs
1602. J. H. G. Wells, Essex-street, Strand—Improvements in pistons for steam and other motive power engines and pumps in general, and which improvements are also applicable to stuffing-boxes. (Communication from E. Rambaud, Lyons)
1603. J. H. G. Wells, Essex-street, Strand—Improvements in governors or regulators. (Communication from E. Rambaud, Lyons)
1604. F. W. Hoffman, New York—An improvement or improvements in breech-loading fire-arms
1605. H. Page, Whitechapel-road—Improvements in ornamenting or decorating glass
1606. J. F. Belleville, Paris—Improvements in generating and applying steam
1607. R. Martineau and B. Smith, Birmingham—Improvements in taps for drawing off liquids
1608. A. V. Newton, Chancery-lane—Improvements in repeating fire-arms. (Communication)
1609. A. V. Newton, Chancery-lane—An improved fountain pen. (Communication)
1610. A. Herts, Bunhill-row, Finsbury—An improved sheet-metal bending and tubing machine. (Communication from W. Webster, Morrisaina, U.S.)
1611. A. Gray, Glasgow, and J. Rawson, Bury, Lancashire—Improvements in means or apparatus for lubricating
1612. L. Mayer, Soho—An improved stuffing to be used in place of hair or other substances in which such articles are commonly employed
1613. S. Short, New London, U.S.—Improvements in horse-shoes and shoes for other animals
1614. H. Pigott, Glasgow—Improvements in hats and other coverings for the head
1615. D. Fisher, Ranelagh-road, Thames-bank—A composition for coating metal plates or wheels used for grinding, sharpening, or polishing

Dated July 9.

1616. W. B. Adams, Adam-street, Adelphi—Improvements in railway wheels, axles, and axle-boxes
1617. A. Krupp, Essen, Prussia—Improvements in the permanent way of railways
1618. R. Bodmer, Thavies-inn, Holborn—Improvements in self-acting apparatus applicable to certain kinds of machines for spinning cotton and other fibrous substances (Communication from E. Stehelin, Bitsch-willer, France)
1619. G. Darlington, Jamaica, and J. Darlington, Cannon-street, London—Improvements in the manufacture or production of zinc or spelter
1620. W. Holroyd, and W. Noble, Queen's-head, Halifax—Improvements in machinery or apparatus for cutting wood and stone
1621. D. W. Hayden, Glasgow—Improvements in fastenings for window shutters
1622. T. Jerome, Great Hampton-street, Birmingham—Improvements in buttons for ornamenting and fastening dresses, as also in loops for attaching or holding buttons on garments while in use
1623. A. W. Williamson, London University, Gower-street—Improvements in obtaining the roots and sugar of commerce
1624. W. Robertson, Manchester—Improvements in machines for spinning and doubling cotton and other fibrous substances, such machines being of the kinds commonly known as mules and twiners or doublers, and in the means of weighting rollers in the same and other machinery
1625. E. Wilson, Eccles-street, Dublin—Improvements in pistons for steam-engines driven by steam or any other elastic fluid, which improvements are also applicable to the pistons or plungers of pumps
1626. M. Defries, Houndsditch—Improvements in moderator and other lamps
1627. R. D. Kay, Accrington, Lancaster—Improvements in machinery or apparatus for pressing, straining, sifting, or refining colours and thickened mordaunts. (Communication)
1628. R. T. Eadon, Sheffield—An improvement in the manufacture of band saws and other endless bands or hoops of metal
1629. H. Adcock, City-road—An improvement in casting iron and other metal

Dated July 10.

1630. F. W. Russell, Aldgate—Improvements in the mode of coupling railway carriages
1631. J. Marsh, Nottingham, and J. Catt, Stepney—Improvements in the manufacture of certain textile fabrics
1632. P. Prince, Derby—Improvements in making moulds for casting railway chairs, other articles
1633. S. Hardacre, Miles Platting, Lancaster—A compound conical spike and spiral double gridded machine for opening, blowing, scutching, and cleaning, cotton, wool, and other fibrous substances
1634. C. W. Lancaster, New Bond-street—An improved method of, or apparatus for, inking, printing, or stamping surfaces. (Communication)
1635. J. Fowler, jun., Havering, Essex, and W. Worby, Ipswich—Improvements in machinery for ploughing and tilling land by steam
1636. S. M. Saxby, Rock Ferry, Chester—Improvements in ascertaining the errors of mariners' compasses

Dated July 11.

1637. R. H. Leadbetter, Glasgow—Improvements in the preparation of flax
1638. R. Harrington, Witham, Essex—Improvements in umbrellas, parasols, walking sticks, whips, &c.
1639. J. Westwood, Lichfield-street, Walsall, Stafford—Improvements in hand, roof, and other railway lamps, parts of which are also applicable to certain descriptions of oil lamps for general purposes
1640. T. Charlton and W. Turnbull, Brentwood, Essex—Improvements in steam generators
1641. H. Dembinski, Rue Joubert, Paris—An apparatus giving a self-acting motive power, produced by weight, elasticity, compressed water, or any gas whatever.
1642. J. B. D. Chevalier, and R. O'Sullivan, Paris—A new or improved method of obtaining or preparing printing surfaces, and in printing therefrom
1643. E. H. C. Monckton, Parthenon Club, Regent-street—The application of a means or process for destroying grubs and other insects or animalculæ, or infusoria injurious to plants
1644. A. N. Worman, Store-street, Bedford-square—Improvements in grand pianofortes

Dated July 12.

1645. B. F. Ortet, Rue de l'Echiquier, Paris—A new metallic composition applicable to the coating of surfaces, and to the moulding and casting of various objects
1646. T. M. Hartwell, J. W. Gladwin, and H. Gladwin, Manchester—Improvements in machinery or apparatus for stretching woven fabrics
1647. W. B. Adams, Adam-street, Adelphi—Improvements in the permanent way of railways
1648. J. Pope, Wincheap-street, Canterbury—Improvements in the application of steam power to ploughing and other agricultural purposes
1649. W. Petrie, Woolwich—A new porous material for filters and other like articles, and for certain modifications or improvements in the manufacture of the material whereby it is adapted to the formation of vessels of capacity, to be employed as a cement, as a water and acid proof lining, as a preservative coating, and as a substitute for stone and earthenware
1650. A. Herts, Bunhill-row, Finsbury—Improved apparatus for holding material during the operation of sewing. (Communication)
1651. J. Avery, Essex-street, Strand—An improved plate holder for photographic and other purposes. (Communication from Madame Millot, Saulto-les-Rethel, France)
1652. J. Rowley, Camberwell—Improvements in the manufacture of a material as a substitute for leather

Dated July 14.

1653. P. B. Rassant, Essex-street, Strand—A new mechanical contrivance for transforming an alternate into a continuous circular motion
654. C. Burrell, St. Nicholas Works, Thetford, Norfolk—Improvements in arranging and rendering portable apparatus suitable for distilling from beet root and other vegetable substances. (Partly a communication)
1655. R. Dendy, Hornchurch, Essex—Improvements in horse-rakes
1656. A. V. Newton, Chancery-lane—An improved mode of securing the plastering of ceilings and walls. (Communication)
1657. W. Williams, Dale, Pembroke—Cutting and dressing stone by machinery

Dated July 15.

1658. J. L. Lucas and A. de Briges, Paris—Improvements in preparing certain liquid or solid alimentary substances from the husk of a certain fruit
1659. W. Edwards, Salford—An improvement or improvements in lathes, applicable also in part or on the whole to tools for boring, shaping, cutting and screwing metals
1660. W. Clibran and J. Clibran, Manchester—Improvements in apparatus or mechanism for regulating and measuring gas
1661. W. Watt, Belfast—Improvements in the manufacture of starch
1662. E. Leigh, Manchester—Improvements in the mode or method of generating steam and applying it for the purpose of obtaining motive power. (Partly a communication)
1663. J. Knowelden, South-street, Southwark-square—Improvements in apparatus for preventing steam boiler explosions
1665. J. H. Johnson, Lincoln's-inn-fields—Improvements in apparatus for consuming smoke, to be applied to lamps and gas burners. (Communication from J. B. T. Andry, Paris)
1666. C. B. Blyth and W. P. Butchart, Dundee—Improvements in weaving.
1667. G. T. Bousfield, Sussex-place, Loughborough-road, Brixton—Improvements in pumps. (Communication)

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Dated July 16.

1668. W. Schmidt and E. Schmidt, Heidelberg, Grand Duchy of Baden—An improved balance for weighing
1669. J. Bourne, Billiter-street—An improved construction of paddle-wheels, usually termed feathering paddle-wheels. (Communication)
1670. H. Turner, Leeds—Improvements in cutting hides for making flexible pipes and for certain other purposes
1671. J. Ford, Preston, and P. Knowles, Bolton-le-Moors—Improvements in machinery for cleaning and preparing cotton and other fibrous substances
1672. A. V. Newton, Chancery-lane—Improved apparatus for obtaining rotary motion. (Communication)
1673. E. Morgan, Acton—A pocket-case for containing address cards, stamps, and other similar articles
1674. T. Duncan, Liverpool—A combined and compound engine for applying motive power, and for measuring fluids.
1676. D. Cameron, Glasgow—Improvements in cranes or lifting and lowering apparatus
1677. J. H. Johnson, Lincoln's-inn-fields—Improvements in circular looms. (Communication from J. N. Poivret, Troyes, France)
1678. G. Eakholme and H. Wilkes, Rotherham—Improvements in ball cocks and cocks in general for drawing off fluids
1679. A. Gurlt, Newington-place, Kennington—Improvements in the manufacture of iron and steel

Dated July 17.

1680. C. Barlow, Chancery-lane—An improved surveying instrument. (Communication)
1681. H. Bragg, jun., Belfast—Improvements in drying air, and in machinery for stretching, drying, and finishing fabrics
1682. F. Andrew and S. Forsell, Manchester—Improvements in machinery or apparatus for sizing, stiffening, dressing and polishing yarns and threads
1683. J. Cartwright, Shrewsbury—Improvements in agricultural implements, called chain harrows, for more effectually dressing and cleaning land
1684. G. Jaque, Auchterarder, Perth—Improvements in the construction of stringed musical instruments
1685. E. Seymour, Bloomfield, New Jersey, U.S.—Improvements in the construction of furnaces. (Communication)
1686. A. V. Newton, Chancery-lane—An improved regulator for heating apparatus. (Communication)
1687. C. Carey, Bessborough-street, Pimlico—Improvements in the vessels and filters used for making infusions of coffee and other substances

Dated July 18.

1689. S. Jay and G. Smith—Improvements in the manufacture of skirts, petticoats, mantles, and such like articles of ladies' dress
1691. E. Mehrel, Paris—Improvements in hand planes
1692. G. F. Hipkins and J. Britten, Birmingham—Improvements in applying springs or weights for the purpose of closing doors or resisting shocks, strains, or pressure
1693. J. Cowley, Quenington, Gloucester—Improvements in the manufacture of paper from straw and other vegetable substances
1694. P. H. Desvignes, Lewisham, Kent—Improvements in machinery for scutching or beating flax, hemp, and other fibrous materials requiring like treatment
1695. J. Gerber, Mulhouse, France—Improvements in printing, dyeing, or impregnating fabrics, yarns, and threads, and in preparing metallic and other powders to be used for these purposes
1696. W. B. Birkby, Upper Rawfold's Card-works, Cleckheaton, Leeds—Improvements in filleting and fixing pointed teeth in the fillets used in the preparation of flax, tow, hemp, and other fibrous substances
1697. J. Hamilton, jun., Liverpool—An improvement in the bending sheet iron, for the manufacture of conical tubes.

Dated July 19.

1698. W. M'Master and J. M'Master, Manchester—An improved apparatus for retaining and releasing cords of window-blinds, or cords, bands, or chains employed for other purposes
1699. G. Hopper, Houghton-le-Spring Iron Works, Durham—Improvements in railway pins or spikes
1700. J. Armour, Kirkton Bleach Works, Renfrew—Improvements in bleaching, washing, or cleansing textile fabrics and materials
1701. J. L. Crockett, West Ham, Essex—Improvements in evaporating. (Communication)
1702. W. Noton, Oldham—Improvements in self-acting mules, and other machines of the like nature, for spinning and doubling
1703. J. Ryder and D. Bentley, Bolton-le-Moors—Improvements in machinery and apparatus for folding and measuring fabrics
1704. W. S. Clark, Warwick-street, Charing-cross—Improvements in machinery or apparatus for digging, pressing, and moulding peat. (Communication from A. Fitts.)
1705. J. L. Crockett, West Ham, Essex—Improvements in the manufacture of sulphuric acid. (Communication)
1706. J. Whitehouse, jun., Birchall-street, Birmingham—Improvements in making, mounting, and spindling knobs, applicable for doors and other purposes
1707. W. A. Jump, Moulton, near Northwich, Chester—Improvements in the manufacture of salt
1708. W. A. Jump, Moulton, near Northwich, Chester—Improvements in apparatus for supplying with fuel the furnaces of steam boilers and other furnaces, and in the method of cleaning the fire bars thereof.
1709. J. Smith, Oldham, and R. Harrison, Manchester—Improvements in machinery or apparatus for warping and beaming
1710. E. W. Young, Maidstone-road, Rochester—Improvements in the construction of bridges
1711. W. Papineau, Harrowbridge, Stratford—An improvement in the production of spirits of wine
1712. R. A. Brooman, Fleet-street—An improved method of supplying air to gas and other lights. (Communication)
1713. H. J. Iliffe and J. Newman, Birmingham—Improvements in the manufacture of buttons

Dated July 21.

1714. J. Warren, J. Jones, and B. Crowther, Clapham-road, Surrey—An improved churn
1715. E. Leak, Longton, Stafford—A thimble pillar, with points and branches, to be used in placing glost china and earthenware in ovens and kilns, when firing, burning, or baking such ware, in lieu of the cockspurs and stilts now in use for that purpose
1716. M. A. A. Gaudin, and E. X. Chouwara, Paris—Manufacturing factitious wholesome milk
1717. F. Barbour, Manchester—Improvements in pen-holders. (Communication from E. W. Hanson and E. G. Kromer, Philadelphia, U.S.)
1718. J. P. Fisher, Edgbaston, near Birmingham—Improvements in cues used at billiards, bagatelle, and other similar games
1719. J. Clark, Newton-heath, Manchester—Improvements in the manufacture of waterproof fabrics
1720. R. Richardson, Great George-street, Westminster, and E. Billips, Llaneley, South Wales—Improvements in the permanent way of railways
1721. J. Gedge, Wellington-street South, Strand—Improvements in obtaining and applying motive power. (Communication from V. Cantillon, Belgium)
1722. F. Simpson, Redhill, Surrey—An improved mode of stopping bottles
1723. M. Vergnes, New York, U.S.—Improvements in electro-galvanic machines for producing motion by galvanic electricity
1724. W. Green, York-street, City-road—Improvements in treating, ornamenting, and waterproofing fabrics, and in machinery or apparatus for effecting the same
1725. J. E. Hodges, Leicester—Improvements in machinery for the manufacture of looped fabrics
1726. S. Statham, Islington, and E. O. W. Whitehouse, Brighton—An improvement in the arrangements for, or working of, electric telegraphs
1727. J. Bing, Hamburgh—A new sauce boat or vessel for containing liquids of different densities

Dated July 22.

1728. A. V. Newton, Chancery-lane—Improvements in machinery for reaping and mowing. (Communication from W. H. Hovey)
1729. C. Amet, Tavistock-street—Improved means of distending articles of dress and preserving the form or shape thereof. (Communication from R. C. Milliet, Besançon, France)
1730. S. Colman, Norwich—Improvements in steam-boilers
1731. E. Weisskopf, Pesth, Hungary—An artificial combustible, chiefly applicable to the kindling of fires.
1732. C. Cowper, Southampton-buildings, Chancery-lane—Improvements in lighting and extinguishing gas lights. (Communication from S. Petit, France)
1733. S. J. A. Berg, Serle-street, Lincoln's-inn—Improved apparatus for preventing the explosion of steam-boilers. (Communication from W. Palmer, New York, U.S.)
1734. H. Hindle, Cavendish-street, Ashton-under-Lyne—Improvements in valves and apparatus for governing steam-engines, and for increasing the safety of steam-boilers
1735. S. Butcher, Bristol—Improvements in kitchen ranges
1736. J. Imray, Bridge-road, Lambeth—Improvements in bending timber
1737. J. Clark, Newton-heath, Manchester—Improvements in the manufacture of beds, mattresses, cushions, and seats

Dated July 23.

1738. J. Brayshay, Cinderhill, Ringley-bridge, near Bolton-le-Moors—Improvements in boilers for generating steam
1739. G. North, Ashburnham-road, Greenwich—An improved spring catch for the security of jewellery and articles of personal ornament and general utility
1740. S. F. Berthiez, Red Lion-street, Borough—An improvement in engines to be worked by a new elastic fluid in substitution of steam generated out of water
1741. F. Potts, Birmingham—Improvements in tags for stay and other laces, as also in the machinery for forming and finishing the same
1743. W. Webster, Bunhill-row—An improved steam and fire-regulator. (Communication from J. Woodruff, New Jersey, U.S.)
1744. W. Webster, Bunhill-row—Improvements in pumps. (Communication from A. Tower, New York)
1745. R. B. Ellison, Brook-street, London-road, Carlisle—Improvements in electric telegraph apparatus
1746. G. Mabie, Rockford City, Winnebago County—Improved machinery for mowing and reaping. (Partly a communication)
1747. A. Bain, Brompton, and B. Heywood, Leicester-square—Improved apparatus for supplying and drawing off liquids and for stopping the flow of liquids and aëriform bodies
1749. J. Derbyshire, Longton Potteries, Stafford—Improvements in cocks, taps, and valves
1750. J. Webster, Moreton-terrace, Pimlico—Improvements in distilling and treating rough turpentine and resinous matters
1751. C. L. Detouche and J. J. E. R. Houdin, jun., Paris—Improvements in the application of clocks and timekeepers, actuated by electricity, to street and other lamps
1752. P. C. Prévôt, Agen, France—An improved railway break

Dated July 24.

1753. H. C. F. M. Petschler, Manchester—Improvements in obtaining and applying motive power, and in the machinery or apparatus connected therewith
1754. J. Ashman, Swansea—Improvements in the manufacture of artificial limbs
1755. C. Burton, Regent-street—Improvements in warming houses and other buildings
1756. G. T. Bousfield, Sussex-place, Loughborough-road, Brixton—An improvement in the manufacture of driving straps or bands. (Communication)
1757. G. T. Bousfield, Sussex-place, Loughborough-road, Brixton—Improvements in the manufacture of flexible hose and tubes. (Communication)
1758. G. Collier and J. Crossley, Halifax, and J. W. Crossley, Brighouse, Halifax—Improvements in finishing and stretching woven fabrics
1759. G. A. Copeland, Constantine, near Falmouth—An improved safety blasting cartridge, for the use of miners and quarrymen
1760. C. T. Judkins, Fleet-street—An improved gas regulator
1761. J. Mather, and W. Forshaw, Bolton-le-Moors—Improvements in pickers for looms and apparatus connected therewith
1762. R. A. Brooman, Fleet-street—Improvements in grindstones. (Communication from B. Picard, Fontenay le Chateau)
1763. C. F. Cattaert, Paris—Improvements in the stoppering of inkstands, bottles, pots, jars, and other vessels, and closing cocks

Dated July 25.

1764. G. T. Bousfield, Sussex-place, Loughborough-road, Brixton—Improvements in the manufacture of vulcanized india-rubber thread. (Communication)
1766. E. Lord, T. Lord, A. Lord, and W. Lord, Todmorden, York—Improvements in machinery for opening, blowing, scutching and preparing cotton and other fibrous substances
1767. W. Wood, Monkhill house, near Pontefract—Improvements in machinery or apparatus for weaving pile fabrics
1768. T. Byford, Carlton-villas, Edgware-road—Improvements in horses' bits
1769. R. Stewart, Glasgow—Improvements in cutting stone and other mineral substances
1770. T. Wrigley, Bury, Lancaster—Improvements in machinery or apparatus for cleaning cotton waste or other materials used in the manufacture of paper
1771. J. H. Johnson, Lincoln's-inn-fields—Improvements in scutching machines. (Communication from C. Leyherr, Leval, France)
1772. S. Jay and G. Smith, Regent-street—Improvements in stuffing or padding couches, cushions, bedding, chairs, and other similar articles
1773. E. Howes, Liverpool—An improved construction of anchor. (Communication from S. Clarke, New York, U.S.)
1774. W. L. Anderson, Norwood—Improvements in propellers
1775. I. Baggs, Manchester-street, Argyle-square—Improvements in apparatus for lighting, signalling, and telegraphing by means of electricity
1776. J. Denis, Queenhithe—Improvements in cutting or perforating steel and other metals. (Communication)

Dated July 26.

1777. J. Platt, Audlem, Chester—Improvements in door knockers
1778. C. Hodges, Manchester—Improvements in apparatus for unwinding silk, thread, or yarn from the hank. (Communication)
1779. R. C. Pauling, Great George-street, Westminster—Improvements in giving increased bouyancy to ships and vessels, in raising sunken vessels, in keeping structures water-tight, and in propelling vessels

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1780. J. Dickinson, Liverpool—Improvements in anchors, and in the manufacture of the same
1781. S. Yeaden, Idle, near Bradford, and G. Chapman, Stockport—Improvements in the construction of reeds for weaving, and in machinery or implements and materials to be used in such construction
1782. G. C. Cooke, George-yard, Lombard-street—Improvements in stereoscopes
1783. H. Remington, Camberwell—Improved gas-heating and cooking apparatus

Dated July 28.

1784. J. Coplin, Falmouth—Improvements in ships' windlasses
1785. G. Ritchie, Ponsonby-street, Pimlico—Improvements in the manufacture of boots and shoes from material not hitherto used for that purpose
1786. H. Robinson, Settle, York—Improvements in arrangements and mechanism for the conveyance or transport of loads or weights
1787. E. Eaborn and M. Robinson, engineers, Clement-street Birmingham—Improvements in machinery to be used for confectionary purposes
1788. W. E. Newton, Chancery-lane—An improved instrument for taking altitudes. (Communication)
1789. W. E. Newton, Chancery-lane—Improvements in steam-engine governors. (Communication)

Dated July 29.

1790. P. J. Livsey, Manchester—Improvements in arrangements and mechanism for rotating and retaining the rollers of window blinds
1791. W. Griffin and E. Duley, Northampton—Improvements in studs and buttons for fastening articles of dress
1793. J. Knowles, Calow, Derby, and W. Buxton, Brimington, Derby—Improvements in tuyeres
1794. W. E. Newton, Chancery-lane—Improvements in the process of generating illuminating gas. (Communication)
1795. H. R. Bowers, Penbedw, near Ruabon, Denbigh—Improvements in machinery or apparatus for grinding, crushing, and pulverizing clay and other substances
1796. G. Davies, Serle-street, Lincoln's-inn—An improved portable apparatus for copying letters and other manuscripts. (Communication)
1797. A. W. Anderson, Trinidad—Improvements in refining sugar

Dated July 30.

1798. F. Caron, Great Titchfield-street—Improvements in fastening handles of door locks and door finger plates
1799. R. W. Sievier, Upper Holloway—Improvements in preserving wood from decay and also from destruction by insects
1800. H. Evette, Lizieux, France—Improvements in looms for weaving
1801. J. Denis, Queenhithe—An improved gelatinous and economical soap. (Communication)
1803. F. C. Simons, Kensington—An improvement in rifling the barrels of fire-arms and ordnance

Dated July 31.

1804. J. Hopwood, Bolton-le-Moors—Improvements in machinery for measuring and folding fabrics
1805. G. Holcroft, Manchester, and P. Johnson, Wigan—Improvements in the manufacture of cement, and in the application of a known material to cementing purposes
1806. J. J. Kerr, Twickenham—Improvements in the manufacture of cartridges for fire-arms
1807. C. J. B. Torassa, Genoa—Improvements in obtaining motive power by the aid of explosive gases
1808. J. Evans, Castleton, Monkton, Pembroke—A progressive lever, by which is obtained an increase of power over the amount of power applied
1809. W. E. Newton, Chancery-lane—A new musical instrument to be played by the agency of steam or highly compressed air. (Communication)
1810. W. E. Newton, Chancery-lane—A new or improved process for obtaining aluminium. (Communication from Messrs Rousseau Frères and P. Morin, Paris)
1811. R. A. Brooman, Fleet-street—An improvement in the construction of carriages and wagons. (Communication)
1812. R. A. Brooman, Fleet-street—An improved augur or boring tool. (Communication)
1813. P. M. J. Chamblant, Rue de Lanery, Paris—Improvements in the manufacture of glass
1814. W. Coltman, Leicester—Improvements in knitting machinery
1815. T. Wicksteed, Coleman-street—Improvements in separating sewage and other matters from water or fluid mixed therewith.
1816. T. Routledge, Gracechurch-street—Improvements in the manufacture of half stuff and paper

Dated August 1.

1817. W. Paton, Springvale, Glasgow—Improvements in railway wheels
1818. A. Tolhausen, Duke-street, Adelphi—A new and improved flexible bocket-umbrella, being likewise applicable to common and other sticks, canes, &c. (Communication from L. A. Mangin, Paris)
1819. J. W. Brett, Hanover-square—Improvements in letter and numeral printing electric telegraphs
1820. W. Wood, Monkhill, near Pontefract, and M. Smith, Heywood, Lancaster—Improvements in looms for weaving terry and cut pile fabrics
1821. W. Wood, Monkhill, near Pontefract, and M. Smith, Heywood, Lancaster—Improvements in apparatus for cutting the wires out of terry fabrics
1823. E. P. Chevalier, Brussels, Belgium—Improvements in the manufacture of cigars
1824. R. A. Tilghman, Philadelphia—Improvements in hydro-extractors or centrifugal machines
1825. R. Reeves, Bratton Westbury, Wilts—Improvements in machinery for sowing or depositing seeds and manure

Dated August 2.

1827. O. Long, Cornhill—Improvements in mechanical knife-cleaners
1829. T. Donkin, Bermondsey—Improvements in the glazing of paper. (Communication)
1831. T. Green, Leeds—Improvements in moving machinery

Dated August 4.

1833. C. G. Gottgetreu, Charterhouse-square—Lithographic printing in oil and varnish colours and metal on glass, wood, papier mâché, marble, metal, porcelain, or any other material that offers a suitable surface
1834. N. Cadiad, Rue de l'Odéon, Paris—The application of centrifugal force for purifying liquids
1835. C. T. Launay and J. Chopin, Paris—Improvements in increasing the illuminating power of gas
1836. G. Walker, and J. Scrimgeour, Belfast—Improvements in spinning frames
1837. T. B. Daft, Dublin—Improvements in the manufacture of cast-iron pipes
1838. A. Wright, Milbank-street, Westminster—Improvements in lighting mines and subterranean places with gas
1839. J. Firth, Heckmondwike, York, and J. Crabtree, Mill-bridge, near Heckmondwike—Weaving Scotch, Kidderminster, and Dutch carpets by means of a power loom

Dated August 5.

1840. H. W. Wood, Briton Ferry, Glamorganshire—Further improvements in the manufacture of fuel, and for a new mode of preserving coal and coke and other fuel
1841. J. B. Bowen, Chipping Norton, Oxford—Improvements in the manufacture of gloves
1842. C. F. Vasserot, Essex-street, Strand—Improvements in machinery for cutting nuts, screws, and pieces of polygonal shape. (Communication from N. Marchal and A. Oger, Epernay, France)
1843. T. Marples, Derby—Improvements in corn mills
1844. A. D. Sisco, Paris—Improvements in railway breaks
1845. A. Smith and W. Smith, Mauchline, Ayr, N.B.—Improvements in ruling or delineating ornamental figures
1846. J. J. Danduran, Charlotte-street, Fitzroy-square—An apparatus called the self-swimmer
1847. E. Blomeley, Fernhill Mill, Bury, Lancaster—Improvements in the manufacture of fabrics applicable to various purposes for which airproof and waterproof fabrics are usually employed
1848. J. Keith, Eltham, Kent—Improved machinery for making envelopes. (Communication
1849. A. V. Newton, Chancery-lane—An improvement in primers for fire-arm cartridges. (Communication)
1850. A. Pfaltz, Massachusetts—A new and useful mode or process for making soap from rosin
1851. J. A. Monnier, Marseilles—Improvements in transmitting motive power

Dated August 6.

1852. A. Mitchell, Liverpool—Improvements in apparatus for exhibiting and distributing advertisements, and for like purposes
1853. G. H. Palmer, Adelaide-road, Haverstock-hill—Improvements in furnaces for generating heat
1855. W. Watt, Belfast—Improvements in treating or preparing Indian corn and other grain for fermentation and distillation
1856. T. Evans, jun., Belmont-terrace, Lewisham-road—Improvements in harness
1857. W. Hall, E. Wylde, and W. Waite, Birmingham—Improvements in steam-engines
1859. J. Farrar, Bury, Lancaster, and H. Spencer, Rochdale—Improvements in apparatusfor regulating the pressure and flow of gaseous fluids

Dated August 7.

1860. L. Weber, Bellevue Hotel, Brussels—A combination applicable to keys of door-locks to prevent their being opened by pliers or other instruments from the outside
1862. W. Green, York-street, City-road—Improvements in the manufacture or production of fabrics and surfaces in imitation of, and as substitutes for, leather for bookbinding and other uses, and in machinery or apparatus for effecting the same
1864. C. Defries, Houndsditch—Improvements in the roof lamps of railway carriages

Dated August 8.

1866. R. Davenport, Jonathan-street, Vauxhall—Certain improvements in kilns for burning pottery, earthenware, china, porcelain, and similar substances, to enable them to consume their own smoke
1870. W. Gorse, Birmingham—A new or improved door fastener. (Communication)
1872. J. Stephens, Suffolk-place, Westminster—An improvement in pipes for smoking

Dated August 9.

1876. T. Whittaker, Accrington, Lancaster—Improvements in the mode or method of washing or cleansing woven fabrics
1878. J. Darlington, Cannon-street, City—Improvements in superheating steam. (Communication from G. A. Hirn, Colmar, Haut Rhine, France)
1880. C. March, Alwalton Mills, Huntingdon—Improvements in propelling and working ships and vessels
1882. E. Owen, Aberdeen-terrace, Blackheath—Improvements in the manufacture of gas, and in the obtainment of products arising in such manufacture

Dated August 11.

1884. P. A. le Comte de Fontainemoreau, South-street, Finsbury—A new electro-motive engine. (Communication)
1886. A. Symons, George-street, Mansion-house, and E. Burgess, Clerkenwell-green—Improvements in noctuarys or telltales for ascertaining the fidelity of watchmen and for other purposes, and in the application of electricity to such apparatus

Dated August 12.

1888. N. D. Maillard, Dublin—An improved mechanical and magnetic compass
1890. E. Firth, Heckmondwike, Leeds—Improvements in finishing mohair cloth
1892. W. H. Brown, Albion Iron and Steel Works, Sheffield—Improvements in steam hammers

Dated August 13.

1894. D. Lesser, Manchester—Improvements in machinery or apparatus for making lozenges, or other similar articles
1896. W. Church, and H. W. Hamlyn, Birmingham—An improved method or improved methods of constructing or building hay and other ricks

Dated August 14.

1898. R. A. Brooman, Fleet-street—Improvements in the manufacture of artificial stone and building and paving materials. (Communication)
1900. A. Priest and W. Woolnough, Iron Works, Kingston-on-Thames—Improvements in horse hoes
1902. M. Bilbe, Nelson Dock, Rotherhithe—Improvements in the construction of ships and other vessels
1904. J. Bannehr, Bedford Circus, Exeter—Improvements in the manufacture of name and sign plates, boards and slabs, door and house numbers, street names, tombstones and monumental slabs, and inscriptions, by substituting earthenware or porcelain instead of the materials now in use for the above-named articles
1906. J. Goddard, Moss-row, Bagslate, near Rochdale, and G. Hulme, George-street, Rochdale—Improvements in carding engines for the more speedy and effectual doffing or stripping of the cotton, woollen, silk, or other fibrous substances therefrom

PATENTS APPLIED FOR WITH COMPLETE SPECIFICATIONS.

1688. F. B. Howell, Lebanon, Ohio, U.S.—Improvements in machinery for making corks. (Communication)—July 18, 1856
1742. J. Onions, Wellington-place, Blackfriars-road—Improvements in the manufacture of iron.—July 23, 1856
1792. R. Thatcher, Oldham—Improvements in preparing for doubling or spinning cotton and other fibrous substances.—July 29, 1856
1826. W. F. Shaw, Massachusetts—An improved burner or apparatus for the combustion of air and inflammable gas.—August 1, 1856.
1854. J. Y. Borland, Manchester—Improvements in machinery for preparing and spinning fibrous materials.—August 6, 1856
1868. J. Woodman, Manchester—An improved telegraph insulator.—August 8, 1856

EXTENSION OF PATENT.

13. J. Lee, Brunswick-street, Trinity-square Southwark—Certain improvements in wheels and axle-trees to be used in railways, and in machinery for stopping on or preventing such carriages from running off railways, which improvements might also be applied to other carriages and machinery, for the term of five years from and after the experation of the term of fourteen years, granted by the original Letters Patent, dated Aug. 8, 1842—Sealed Aug. 8, 1856

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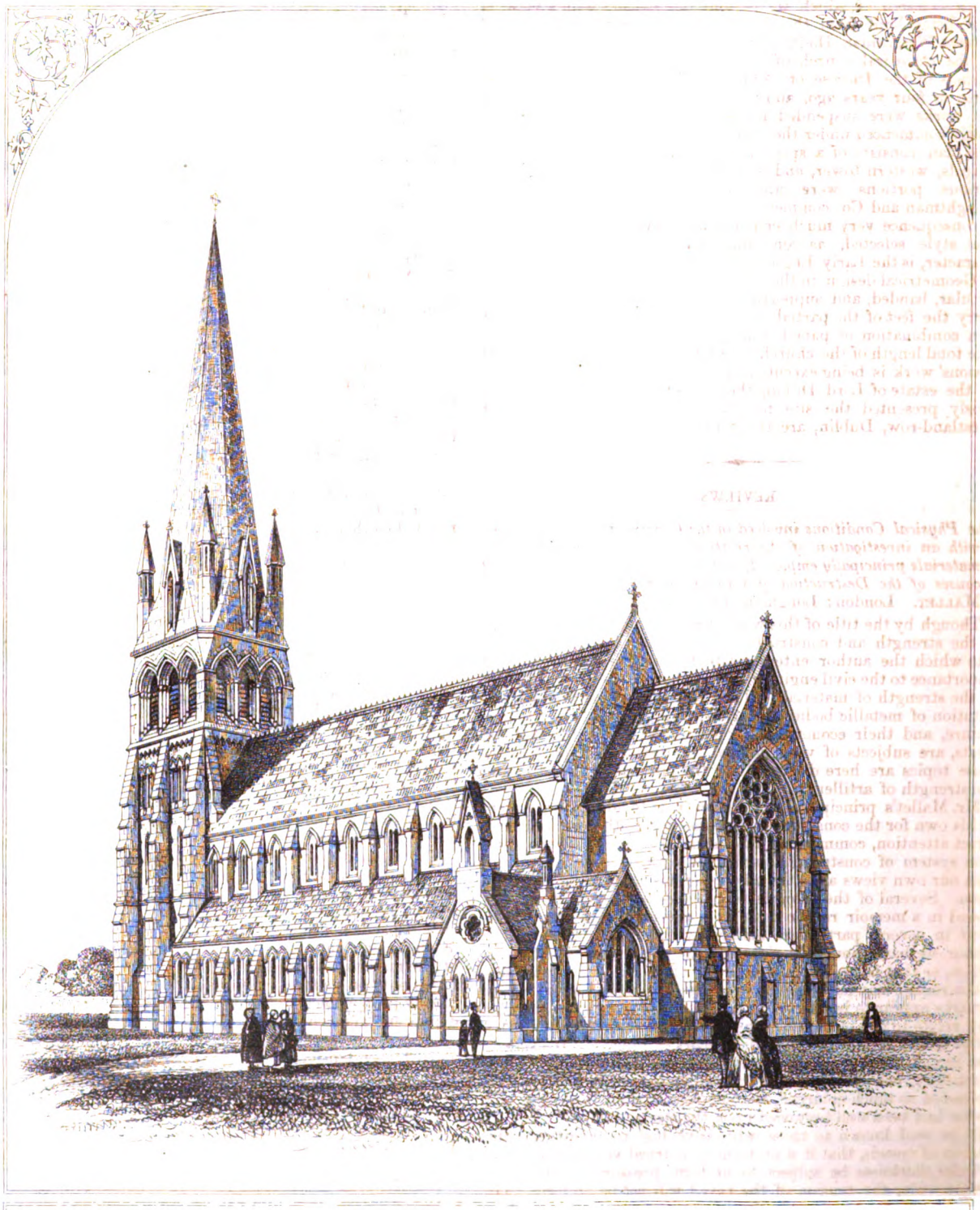

View of New Cathedral Ballaghadreen: Co: Mayo.

G. Goyder

WEIGHTMAN HADFIELD & GOLDIE, ARCH.TS
SHEFFIELD

J.R Johns

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CATHEDRAL CHURCH, BALLAGHADRUN, COUNTY MAYO, IRELAND.

(With an Engraving, Plate XXIX.)

This church, of which we present our readers with a view, is now being built from the designs and under the direction of Messrs. Weightman, Hadfield, and Goldie, architects, of Sheffield, as the cathedral church of the Right Rev. Dr. Durgan, R.C. Bishop of the Diocese of Achonry. It was commenced some three or four years ago, and after laying the basement course, the works were suspended for some time, until they were recently commenced under the direction of the above-named firm. The plan consists of a spacious nave and aisles, chancel, side chapels, western tower, and sacristy. The proportions of these various portions were already determined before Messrs. Weightman and Co. commenced operations, and they have been in consequence very much crippled in carrying out their design. The style selected, as combining economy with ecclesiastical character, is the Early English, with a somewhat later character of Geometrical design in the chancel. The internal columns are circular, banded, and supporting on their caps the shafts which carry the feet of the partial groining of the roof, which is formed of a combination of panelled wagon-head ceiling and groining. The total length of the church is 168 feet by 59 feet. The whole masons' work is being executed in blue limestone from quarries on the estate of Lord Dillon, the lord of the manor, who generously presented the site for the edifice. Messrs. Doolin, of Westland-row, Dublin, are the contractors.

REVIEWS

The Physical Conditions involved in the Construction of Artillery; with an investigation of the relative and absolute values of the materials principally employed, and of some hitherto unexplained causes of the Destruction of Cannon in Service. By Robert Mallet. London: Longman. 1856. 4to. pp. 283.

Though by the title of this work it would appear to treat solely of the strength and construction of cannons, the investigations into which the author enters relate to subjects of the highest importance to the civil engineer and student of the general theory of the strength of materials. The chemical and mechanical constitution of metallic bodies, their forms of fracture, their manufacture, and their economical properties, of which this volume treats, are subjects of very general interest, though professedly those topics are here discussed for the purpose of investigating the strength of artillery.

Mr. Mallet's principal object, however, is to advocate a system of his own for the construction of guns, and to this we shall first direct attention, commencing by stating the defects of the common system of construction which he endeavours to avoid, and then our own views as to the efficacy of his methods of avoiding them. Several of the subjects to be considered ought to be discussed in a memoir rather than in a review; but as our conclusions in several particulars materially differ from those of the author, we have thought it right to state our processes of investigation, so that those who are desirous of checking the accuracy of the results may have the opportunity of doing so. And if these remarks appear to be carried to undue length, our excuse is that they relate to one of the most instructive examples of the theory of the strength of materials which occurs in practice. We believe that any civil engineer who thoroughly mastered the mechanics of artillery, would find his conceptions on the subjects of his own profession so much enlarged, that he would think his time and labour had been well bestowed upon the study.

It is well known to those who have had to investigate the tension of vessels, that if a uniform cylindrical vessel of material of finite thickness be subject to uniform pressure on its inner surface only, the tension of the vessel will *not* be uniform. On the contrary, the tension will be greatest on the inner surface and decrease towards the exterior. A consequence of this is, as we shall consider more fully presently, that such a vessel may be subject to a rupturing tension inside, before its outside is strained at all.

The cause of this inequality of strains may be explained as follows. Suppose the thickness of the material of the cylinder made up of any number of concentric cylindrical shells. An expansion of the innermost shell by tension will cause it to press on the next shell. The consequent expansion of that will cause it to press on the next to it, and so on to the outermost shell. Now, if these shells were not closely fitting, it is clear that the first would be expanded somewhat, before it began to press the second; and that would be expanded somewhat, before it began to press the third. It is true, that we cannot suppose that any interval in reality exists between these hypothetical shells before they are expanded, but the *compressibility of their thickness* by their mutual normal pressure produces the like effect as the supposed intervals. It can easily be seen that if the material between the innermost and outermost shell were very soft, the first shell would have to be expanded very much before the outermost shell began to expand at all. Therefore, it might happen that the inner shell burst before even the outer shell came into use.

We proceed to investigate more precisely the tensions of the different parts of the cylinder,—after stating why we are not satisfied with the investigation, for the same purpose given in the Appendix to the work before us, and written by Mr. Hart, Fellow of Trinity College, Dublin. He has stated so fairly and clearly the objections to his method, that we cannot do better than quote his own words. He states that his conclusion depends "upon the following admissions—First, that the extending force bears a constant ratio k to the extension; secondly, that the compressing force bears a constant ratio k' to the compression; and, thirdly, that fracture only occurs when the extension has exceeded the limit m; but it still remains to be proved by experiment, whether the resistance to extension is diminished or increased by simultaneous compression in a transverse direction, and *vice versâ*. Judging from the fact that the extension of a piece of india-rubber produces a visible compression in the transverse direction, and *vice versâ*, it seems probable that the effect of either of these forces must diminish considerably the power to resist the other; and if this be so, the resistance of the tube will be lessened; it is also conceivable that a very great compression might of itself produce fracture, *i. e.* disintegration, without any extension; or might (before reaching the crushing limit) make the material more easily broken by a transverse tension."

Our objection to Mr. Hart's method may be shortly summed up in this—that he does not investigate the normal compression of the cylinder; that is, the effect of mutual pressure of the consecutive cylindrical shells above mentioned, by which the extension of one produces extension of the others. The theory which we shall adopt on this subject is an extension of the well-known "Hooke's law," on which the general equations of elasticity of Cauchy, and those given by Professor Stokes in the eighth volume of the *Cambridge Transactions*, and the investigations of many other mathematicians, are founded. An admirable investigation of these general equations is given by Mr. Maxwell in a memoir on the 'Equilibrium of Elastic Solids,' in the *Edinburgh Transactions*, vol. xx.

The relations between the co-efficients of normal and tangential elasticity just referred to, may, we think, be determined as follows. If a cube of elastic material be subject to external normal pressures or tensions, the displacement of each face of the cube depends not only on the elasticity in the direction of that displacement, but also on the *cubical* condensation or dilatation of the material. So that if the cube be subject to perpendicular forces only on its faces, the pressure on any face would be not merely proportional to the displacement in its own direction, but dependent also on the lateral displacements, for on the latter depends the cubical condensation or dilatation. When this is neglected, each tension is, according to Hooke's law, in a constant ratio (e) to the extension in its own direction. When the cubical extension is introduced, experiment leads to the conclusion that the consequent additional tension is approximately in a constant ratio to the cubical extension. This ratio (E) is the same for all directions of the strain when the material is equally elastic in all directions.

Let the dimensions of the cube be unity, and let c be the cubical compression; l, n, t, the tensions on three contiguous faces of the cube; λ, ν, τ, the displacement produced by them. Then, by the principles just laid down,

$$\left.\begin{aligned} l &= \mathrm{E}c + e\lambda \\ n &= \mathrm{E}c + e\nu \\ t &= \mathrm{E}c + e\tau \end{aligned}\right\} \quad \ldots\ldots\ldots\ldots\ldots\ldots \text{(1.)}$$

These equations represent, in fact, the first terms of the expansion of the function which each pressure is of the two sorts of compressions.

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It may be easily seen geometrically that o, the compression of the cubic unit, is equal to $\lambda + \nu + \tau$, neglecting the terms involving the powers and products of these small quantities. Hence the first of the above equations becomes

$$l = E(\lambda + \nu + \tau) + \sigma\lambda \quad \ldots\ldots\ldots\ldots\ldots (2.)$$

If we assumed one of these tensions (l), and also the extension in the same direction (λ), to be constant, it would follow from the last equation (2) that $\nu + \tau$ is constant also. Hence, we easily find from the last two equations of (1) that $n + t$ is constant also, or

$$n + t = C \quad \ldots\ldots\ldots\ldots\ldots (3.)$$

We proceed now to apply these considerations to the problem before us. The question, which has immediate connection with the investigation of the strength of cannon, is, what are the elastic forces exerted by a uniform cylindrical vessel subject to a uniform pressure of its interior surface,—the longitudinal strains and tensions—that is, those parallel to the axis of the cylinder—being supposed to be the same in every part. This latter supposition is not strictly accurate, but we shall presently show that it is sufficiently so for the purpose of this investigation.

The quantities l, n, t, in the preceding investigations represent here the longitudinal, normal, and tangential tensions respectively at any point on each unit of area in sections respectively perpendicular to those forces. Also λ, ν, τ, are the extensions in corresponding directions of a unit of length of the material. By what has just been said, l and λ are considered constant, and if the material be supposed equally elastic in all directions, the equation (3) holds in the present case, whatever three directions of these normal pressures are taken. There are no strains of torsion.

Consider now the equilibrium of a small element of the metal $b\,B\,d\,D$, bounded by contiguous cylindrical surfaces $b\,B$, $d\,D$, by planes $b\,d$, $B\,D$, through the axis A of the cylinder, and planes perpendicular to A a unit of distance apart.

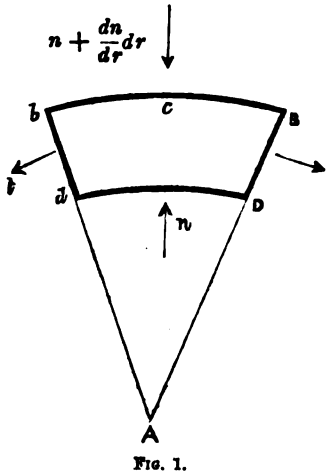

Fig. 1.

Let the angle $b\,A\,B = d\theta$, and $c\,A\,B = \frac{1}{2}\,d\theta$. Resolve forces along $A\,c$. Let r be the radius $A\,D$, $r + dr$ the radius $A\,B$. Therefore the surface at $d\,D = r\,\theta$, and at $b\,B = (r + dr)\,d\theta$. Each unit of the former is subject to the pressure n; each unit of the latter to the pressure $n + \frac{dn}{dr}\,dr$. The tensions at $b\,d$ and $B\,D$ are obviously equal (t), and there is no friction, there being no reason why such a force should act in any particular direction.

The resolved part of t along $A\,c$ is $t \sin \frac{1}{2}\,d\theta = t \cdot \frac{1}{2}\,\theta$. The two forces t act on surfaces dr; therefore their total resolved effect $= t\,d\theta\,dr$. Hence for the equilibrium of the element

$$t\,d\theta\,dr = n\,r\,d\theta - \left(n + \frac{dn}{dr}dr\right)(r + dr)\,d\theta$$

$$= -n\,dr\,d\theta - \frac{dn}{dr}\,dr\,d\theta\,(r + dr).$$

$$\text{Hence } t + n = -r\,\frac{dn}{dr} \text{ ultimately} \quad \ldots\ldots\ldots (4.)$$

But from (3) putting $-n$ for n, since the force there regarded as a tension is in the figure represented as a pressure,

$$t - n = C \quad \ldots\ldots\ldots\ldots\ldots (5.)$$

Subtracting this equation from the last,

$$2n = -r\,\frac{dn}{dr} - C,$$

of which the integral is, c being a new constant introduced by integration,

$$n = -\frac{c}{r^2} - \frac{C}{2}.$$

To evaluate these constants, let R be the radius of the external, a the radius of the internal cylindrical surface; p the unit of pressure on the latter. Then, when $r = a$, $n = p$; when $r = R$, $n = 0$. Hence,

$$n = \frac{a^2}{r^2}\,\frac{R^2 - r^2}{R^2 - a^2} \cdot p \quad \ldots\ldots\ldots\ldots\ldots (6.)$$

And from (5) giving C its valuated evaluated as above,

$$t = \frac{a^2}{r^2}\,\frac{R^2 + r^2}{R^2 - a^2} \cdot p \quad \ldots\ldots\ldots\ldots\ldots (7.)$$

The formulæ (6) and (7) coincide *mutatis mutandis* with those arrived at in a different way by Mr. Maxwell in his paper already referred to (p. 99). The formula (6) is also identical with that of Mr. Hart in the volume before us, and with that of Dr. Harte quoted in the same work, p. 145; and when the difference between R and a is small, coincides with the simple formula of Morin (*ib.*)

From (7) the tension of the interior surface of the cylinder is found (by putting $r = a$) to be,

$$\frac{R^2 + a^2}{R^2 - a^2}\,p \quad \ldots\ldots\ldots\ldots\ldots (8.)$$

If a were very small compared with R in this expression, that is, if the thickness were infinite, the tension would be equal to p. It follows, that *however thick the material, the cylinder cannot resist rupture when the pressure per square inch on its inner surface equals the ultimate tensile strength of the material.*

Having thus obtained a formula for the computation of the strength of cannons considered as uniform cylindrical tubes subject to uniform strains in the direction of their axes, we proceed to describe the construction adopted by Mr. Mallet, and to ascertain the comparative strength of cannon so constructed.

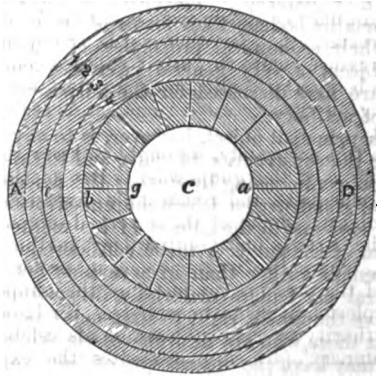

Fig. 2.

The construction he advocates is that of a "built-up wrought-iron gun," for which he proposes to construct "a number of longitudinal prismatic bars of metal, parallel to the axis of the gun, and forming a cylinder of equal voussoirs, and grasp these externally by a set of successive closely-fitting cylinders, whose total thickness is Ab, and of which the inner half of their total number (3 and 4) is in a state of compression, while the outer half (1 and 2) is in a state of extension." The external cylinders "as they cannot practically be superimposed and closely fitting, if consisting each of a single piece equal to the whole length of the gun, must consist of a number of comparatively short rings applied end to end." The circular rings "will be closely fitted by shrinking on at a suitable heat." He considers that by causing "each successive cylinder to grasp and compress the preceding ones within it with a force inversely proportionate to that with which it will be afterwards extended, we should have attained *at a certain pressure* a perfectly equal extension for all successive cylinders, so that their united resistance might be considered as

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centered in the middle points *e* or D, and hence that the whole section of metal due to the gun's thickness from *g* to A would be equally effective in resisting the internal pressure as though its resolved forces produced a straight pull on the tangent at *e* perpendicular to A D, and that the metal of the gun were a straight bar of the breadth A*g*, and unit of depth resisting in the opposite direction but in the same line." (p. 147-9.)

This, as it seems to us, is a fallacy, and upon it the whole of Mr. Mallet's scheme for the improvement of guns is founded. In assuming that such a relation can be established between the compressions and tensions of the several cylinders originally, that after the pressure of the gunpowder is applied they shall all be in the same state of tension, he seems to us to have entirely overlooked the effect of the normal elasticity in determining that relation. It cannot be determined arbitrarily by any contrivance of "shrinking on" at different temperatures, for immediately that any one of the rings is so fastened on, it produces a normal compression and alters the tension of all the other rings, in a degree depending SOLELY on the magnitude of the rings if the material be supposed equally elastic; or, if not, then on those magnitudes and the several coefficients of elasticity. ***But in no case do the relative degrees of tension of the built-up gun depend on the tensions with which the rings were successively fastened on.*** This appears at once from equation (7), which is equally true whether any of the rings were stretched or compressed before the pressure *p* was applied, and we cannot help thinking that both Mr. Hart and Mr. Mallet have fallen into a fundamental error in supposing that by any such contrivance they can alter *ad libitum* the tensions after *p* is applied. Whatever the tensions and compressions might have been originally, the rings so accommodate themselves to each other *by means of the normal compressions* that the tensions of the complete gun must increase from the interior outwards in quantities proportional to the square of the distance from the axis of the cylinder—as in equation (7). To suppose that by any method of preparing the gun this difficulty could be avoided, would be to suppose that the ingenuity of man could evade the laws of mechanics.

The utmost that can be done to save material by originally compressing part of the gun, may be seen as follows. Let us consider at what distance from the axis rupture should occur in order that the cylinder may previously sustain the greatest possible pressure (*p*). Suppose the tension to be that of rupture and *r* the distance from the axis where it occurs. Then R and *a* being assigned, it can easily be shown from equation (7) that *p* will be greater the greater *r* is. In other words, the cylinder will bear the greatest pressure before rupture if rupture commence on its outside. This being the condition of greatest strength arising from shrinking on of successive rings, let us see what economy results from it.

To ascertain this accurately, we ought to know the value of *p*, the explosive force of the gunpowder. But of this our knowledge is very inadequate, and remarkable diversities of opinions exist on the subject. Some of these very discrepant results are collected in the Article on "Gunpowder," in the *Encyclopædia Metropolitana*, where the writer seems to prefer Dr. Hutton's computation of the pressure produced by the gunpowder at the moment of explosion at 2000 atmospheres. Sir Howard Douglas, an eminent authority on such subjects, in his celebrated treatise on 'Naval Gunnery' (4th ed. p. 39), cites the experiments by which Dr. Gregory found the force of fired gunpowder equivalent to 2250 times the pressure of the atmospheres (*i. e.* about half the tension of rupture of wrought-iron). He states, however, that the state of knowledge on the subject is very imperfect. We must observe, however, that Mr. Mallet seems to enormously over-estimate the force which a gun may have to resist, in one place (p. 237) where he speaks of the maximum pressure per square inch in a certain case being six-fold the ultimate coefficient of rupture of the material. We consider it demonstrable by the process by which the expression (8) is arrived at, that the explosive force *p* can never be so great as the tension of ultimate rupture. For if T be that tension, we have from (8),

$$T = \frac{R^2 + a^2}{R^2 - a^2} p \quad \ldots\ldots\ldots\ldots\ldots\ldots (9.)$$

And in order that *p* should be equal to T, R must be infinitely great compared with *a*, or the thickness infinitely great.

Suppose now, according to the preceding data, that *p* is one-half the tensile force T. Then, from equation (9), we find $R^2 = 3a^2$, or the requisite thickness of the common gun $= \cdot 73\, a$ ..... (10.)

Again, taking the most favourable case of the complex gun, which we have just shown to be where rupture commences on the outside of the gun, we have from (7), putting $r = R$, and $t = T$

$$T = \frac{2b^2}{R^2 - b^2} p' \quad \ldots\ldots\ldots\ldots\ldots\ldots (11)$$

as the condition of rupture of the complex gun, b ($= c\,b$ in the second figure) being used instead of *a* to denote the radius of the interior surface of the least cylindrical ring, and p' the pressure communicated to that surface by the voussoirs.

As the complex gun is made up of rings, the thickness requisite to resist longitudinal strain (*i. e.* along the axis), which Mr. Mallet provides for by voussoirs, has to be considered.

In order to render the comparison complete, we must suppose the bores of the two guns the same. Therefore, in the complex gun the smaller radius of the voussoirs is *a*; their greater radius is *b*. The explosive force along the axis is $p \pi b^2$, and the total tension parallel to the axis is $T \pi (b^2 - a^2)$. We shall presently show that these two forces may be regarded as equal, or

$$p\,b^2 = T\,(b^2 - a^2).$$

Giving *p* and T the same values as before, we find hence $2a^2 = b^2$, whence the thickness due to longitudinal tension is equal to $\cdot 414\, a$, and the outer radius of the cylinders or

$$b = 1 \cdot 414\, a = \sqrt{2}\,.\,a.$$

To find the normal pressure p' which voussoirs of this thickness communicate to the inner cylinder of the complex gun, we cannot make use of equations (6) and (7), because there is a discontinuity of the material of the voussoirs at their joints, which is not taken into account in those equations. If they were used, the voussoirs might appear to exert forces of *tension* on each other, which is impossible. Again, if they exerted *pressure* on each other, that would increase the tendency to rupture. The most favourable hypothesis, therefore, is to suppose the material of the voussoirs so apportioned that when the pressure *p* is applied, they are just in contact without mutual pressure. It can easily be shown that, consequently, the pressures on their cylindrical surfaces, if uniform, are inversely as their radii, or

$$p\,a = p'b.$$

Giving p' this value and writing *b* for *a*, in (8), we find the condition of rupture of the outside of the complex gun to be

$$T = \frac{R^2 + b^2}{R^2 - b^2} \cdot \frac{a}{b} p;$$

whence remembering that $b^2 = 2a^2$, and $T = 2p$, we get,

$$R^2 (2\sqrt{2} - 1) = 2a^2 (2\sqrt{2} + 1),$$

$$\text{or } R^2 = 4 \cdot 18\, a^2; \qquad R = 2a \text{ nearly.}$$

Whence the total thickness of the complex gun is *a little greater than the radius of the bore.*

We found, however, from (11) that the requisite thickness of the common gun is only $\cdot 73a$. It follows that *the complex gun requires more metal to resist the given pressure than the common gun, and to have the same strength must have more than one-third greater thickness.*

An assumption has been made throughout the preceding calculations that the longitudinal tension is, under ordinary circumstances, uniform and equal in total amount to the projectile force. That this assumption is nearly correct may be seen as follows.

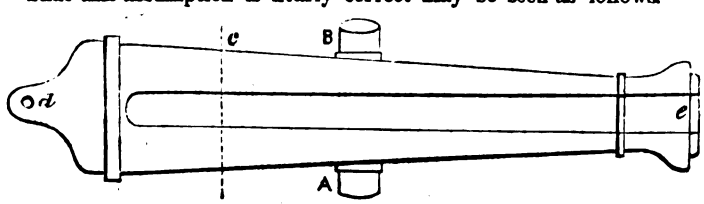

FIG. 8.

Let the axis of the gun be supposed to be horizontal, and let a horizontal section through it be represented by the figure. Let A B be the axis of the trunnions. Let another section parallel to that axis and between it and the breech be made perpendicular to the axis of the gun, and indicated by the dotted line *c*. Call the total tension of the gun perpendicular to this section, T. Then, if M be the total mass between *c* and *e*, and V the velocity of recoil, we have for the motion of M,

$$M \frac{dV}{dt} = T.$$

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This mass M includes the mass of the gun carriage, for by reason of the connection of the trunnions that is part of the mass moved by T. Again, if N be the *total* mass of the gun and carriage, P the total force reacting on the breech,

$$N \frac{dV}{dt} = P.$$

Comparing these two equations, we have

$$\frac{M}{N} = \frac{T}{P};$$

from which the longitudinal tension of any part of the gun can be immediately and accurately ascertained. For parts near the breech, however, it is obvious that M may be taken = N, and T = P, as we have assumed. So long as the gun has any recoil, this relation holds, (even if instead of trunnions the gun's recoil were resisted, as Mr. Mallet proposes, by springs at *d*,) if the mass between *c* and *d* be taken small compared with the total mass of the gun alone.

Mr. Mallet has some views on this subject which are to us utterly unintelligible. His use of mathematical terms is occasionally so different from their ordinary use in mathematics, that we are by no means certain that we understand him. The following would seem to show that he confounds *momentum* with *vis viva*. He says (p. 129) that if P and P′ be the weights of the shot and gun, "$\frac{P}{g} V^2 = \frac{P'}{g} V'^2$, the *vis viva* of the shot and the recoil." This is clearly wrong. It should be $\frac{P}{g} V = \frac{P'}{g} V'$, or the momentum of the shot = that of recoil. Again, he says (p. 134) that $M'v'^2$, the *vis viva* of recoil, is "transferred as a pressure against the interior of the breech," though how *vis viva*, which is equivalent to a product of pressure and distance, can be equal to pressure alone, we do not understand. A little further on, we find, "If F, then, be the work done to tear the gun in two at the section *y*, and *t* = the momentary time of the traject of the shot along the chase until leaving the muzzle, $\frac{M'v'^2}{2} t = F t$ will be the longitudinal strain on the gun." Here *vis viva* receives a new application, but not more felicitous than the last. Before, *vis viva* was equivalent to a force; now, *vis viva* × time, or force × distance × time is made equal to force alone! We do not pretend to unravel this mystery. Another view of *vis viva* is taken in equation (56), p. 123, where it is represented to be the product of the square of velocity and pressure! We are also informed that when a pressure P is applied suddenly, "its effect is measured by the square of the velocity Pv^2." This proposition, that the effect of a pressure is measured by that pressure × square of velocity, has at least the merit of novelty.

(To be continued.)

Monumental Memorials: being designs for Headstones and Mural Monuments. Part I. By J. W. Hallam, Architect. London: Masters. 1856.

With the revival of Pointed architecture and the faithful restoration of ancient churches, there revived also that seemly regard to memorials for the dead, and that consistent arrangement of churchyards which has led to the publication of very many suggestions for this end, and of designs more or less worthy of practical realisation. The Camden Society did much towards this movement, and the excellent work by Mr. Paget, and subsequent ones by other clergymen,—Mr. Hastings Kelke, and Mr. Cutts, for instance, have helped it on. The humblest headstone and the most elaborate monument may equally evince a good or bad style, a Christian or a Pagan aspect. A sepulchral memorial, unbecoming its situation and object, manifests a defective judgment, or a culpable indifference in the person who erected it. The ornaments which till lately were usual on gravestones we now vote at once fantastic and ridiculous. Often a cherub's head, with puffed cheeks and outspread wings, formed by one continuous line of clever flourishing, would *adorn* the upper part, while the inscription, written in letters of various shape and character, was embellished with a profusion of unmeaning flourishes. But the day for this rude carving and this ornamental penmanship is doubtless now passed, and with them the retinue of urns, broken columns, pyramids, funereal and inverted torches, cupids weeping or blowing trumpets, &c., which are all emblems of pagan superstitions, or copied from pagan sculpture. Nor are subjects of Popish reference admissible, such as their saints, allusions to Romish legends and doctrines, griffins, fabulous serpents, and the like, and emblems of perishing mortality, such as skeletons, emaciated bodies, skulls, &c., less objectionable. Among emblems, that of the Cross is by far the most fitting, as a symbol of our faith, and the sacred monogram would not be an improper recognition. So also distinguishing official and professional symbols of a Protestant character may also be used for the laity. Thus a mitre for a bishop, a chalice for a priest, and armorial insignia, where they have been borne in life, are equally admissible on sepulchral monuments.

In the Part before us are thirteen designs for headstones, and four for mural monuments, prefixed by a brief introduction, and each explained by a short reference. When we say that the majority of these designs are unexceptionable, and evidently prompted by feelings akin to those we have just expressed, it will hardly be needful to add anything more. In each of the headstones we observe that the Cross is a prominent feature, while the mural slabs are enriched with roses or foliage in panels and spandrels merely. There is no objection to these, but the contrast is noticeable. The design No. 8 is the only one of its kind given: it is a coped tomb, with a floriated cross, and a chalice on the stem, and has been executed in memory of a clergyman at Clifton. The design, which is not very original, is by Mr. Robinson of Leamington. In some cases metal-work is proposed in conjunction with stone, but there is an evident want of harmony in the materials which will prevent their being much used in such combinations. In design 6, where a metal cross is appended to the head of an oak rail, with arms, it is much more in place, and this is an idea really well managed. No. 9 has been evidently suggested by the gable cross on a Northamptonshire church, but is far preferable to the following design, in which iron and stone are oddly grouped. Still, on the whole, the book promises to be of the right stamp, and the illustrations, though drawn with a very free hand, and somewhat tricked off, are sufficiently clear to be decidedly useful.

THE INTENDED GOVERNMENT OFFICES.

The comprehensive magnitude of the scheme, and the unprecedented number as well as actual value of the premiums offered for designs for the intended Offices, cannot fail to put the whole architectural profession upon the *qui vive*. Even those who do not intend to enter into the actual arena of competition, will look on with the excitement of anxious spectators. Whether the chance of obtaining one of the lesser premiums will induce many to compete who would not else think of doing so, is what remains to be seen. The aggregate amount of the premiums is no less than 5000*l.*, viz.: seven for the War-Office, 2500*l.*; five for the Foreign-Office, 1700*l.*; and three for a block plan, 800*l.* As to the last mentioned subject, it quite puzzles us to understand what can be meant by "block-plan," because a premium of 500*l.* for the best one strikes us as being altogether preposterous. It can be only a single drawing, and that one no more than a mere diagram or map indicating the relative position of the several buildings; which, as far as we can perceive, is already shaped out.

Up to the time of our present writing, nothing further has transpired since the publication of the first official programme, not even the "particulars" that are to be applied for being yet obtainable—a rather ominous delay at the very outset, when unusual expedition is looked for from architects, the first of February next being the latest day on which designs can be received. Hardly, we think, can that regulation be now adhered to. Extension of time there must be; and it would be better that it should be granted beforehand, than at a later period when architects are actually at work upon their designs, under the disadvantage of having been obliged to commence them very hurriedly without waiting for counsel from second thoughts. Extension of time ought to be applied for and granted at the very first; not extorted when the time first allowed has nearly expired, and when the granting it is almost tantamount to a confession of having made a gross miscalculation. Distance, moreover, abridges time: even that marvel of marvels, the electric telegraph, all capable as it is of wafting a whisper from one pole of our planet to the other, has yet to learn how to

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transmit lithographed plans of the site to foreign competitors. Or are they to have such plans and other instructions sent them before English architects are supplied with such necessary information, in order that all may start alike at one and the same moment?

To say the truth, we have considerable doubts as to the policy of throwing open the competition to all the world—the architects of all countries—not that there is much danger of many of them being enticed into a chase after the brilliant *ignis fatuus* flourished before their eyes by Sir Benjamin Hall. Still, we are at liberty to suppose, just for a moment, that the invitation is freely responded to. We behold in imagination the countless piles of packages of drawings, from all the four quarters of the globe, that pour in upon poor Sir Benjamin. The cry is, "Still, they come!" "Sir Hall," as foreigners would style him, finds to his dismay that his namesake, the Hall of Westminster, will not so much as contain them; and where their contents are to be opened, arranged, mustered, exhibited, no one can tell; for if fairly laid out they would cover—to the great delight of dealers in drawing-paper—not a few square miles. Not that we ourselves fearfully anticipate any such awful deluge of designs flowing in upon us from foreign parts; we merely put the case hypothetically, and with the charitable intention of rendering it evident how much less of wit than of nonsense is required for making up a dose of grotesque exaggeration.

To speak now more soberly, after the above *escapade* from our pen, we cannot help seeing, liberal as it may be, something objectionable also in the inviting foreigners to compete with our own architects. Unless the whole affair be a juggle—it being predetermined that although some of the premiums may be awarded to foreign architects, no foreigner shall be allowed to carry off the grand prize—it would be in no small degree galling to the English public as well as to the architectural profession, were, after an open contest of professional skill, the prize to be decreed to any other than an Englishman. The case would be altogether different from a foreign artist being called in and employed in preference to a native one. In such instances, John Bull can console himself with grumbling: his national vanity is not touched to the very quick; the preference of a foreigner can be ascribed to favouritism, fashion, folly. Where no combat was allowed to take place, the foreigner cannot boast of having obtained a victory.

It becomes a question again whether, if architects from other countries are to compete, the committee, commission, or whatever else may be the designation adopted by those who are to sit in judgment upon the designs, ought in propriety, to consist entirely of Englishmen. Be that as it may, it is to be hoped that as the occasion is one of such importance, we shall for the very first time learn, not the mere result alone of their deliberations, which of course cannot be concealed, but all the *pros* and *cons* brought forward in discussion, and what was the "last feather" which, when victory was doubtful, turned the scale in favour of the selected design. Hitherto, all that has ever been communicated to the public on similar occasions—the competition for the Houses of Parliament, for instance—has been the bare fact of the decision. Hardly is a perfectly unanimous verdict to be looked for in any important case of the kind, more especially at the present day when the number of those who interest themselves in architecture is so much greater than it was twenty years ago, and when strangely conflicting tastes and opinions respecting it have shown themselves. If therefore, as is most likely, the forthcoming competition will have to be decided by a majority of votes, not only ought that to be declared, but we ought to be informed who are the dissentients, and likewise the grounds for their dissent. Why should there not be a "Blue-book," faithfully reporting all that passed and was said in the several sittings of the committee? We engage for its obtaining a very much larger circle of readers than any other of that blue-coat school of official literature.

Passing from this topic, we have yet to learn whether any of the suggestions made by the professional gentlemen whom Sir Benjamin Hall invited to confer with him on the matter, were adopted, and if so, were of a nature to affect the original programme, and render some alteration necessary. If the subject of style was touched upon at all, wide difference of opinion must, we fancy, have been expressed; several of the architects present on the occasion being decided, we may say ultra, mediævalists—to such a degree, in fact, that more likely than not, even the New Palace of Westminster finds very little favour in their eyes, being looked upon by them as no better than Gothic of very degenerate and equivocal character, and expiring in the last stage of a rapid consumption. To Sir Charles Barry, on the contrary, it must be matter of indifference what style be adopted, for if it should not accord with his pile at Westminster, it will be in keeping with what he has done at Whitehall, and *vice versâ*. Nothing being stated to the contrary, the natural presumption is that modern classical is to be the style of the new Official buildings. Still it is desirable that no room should be left for doubt on that point. The leaving "Style" an open question, apparently at least, quite at the option of the respective competitors, is far more likely to embarrass those who will have to decide between the claims of opposite styles, to do at last what, if not with less perplexity to themselves, with far greater consideration for others—for those whom they invite to compete—they might do at first.

To digress here for a moment, we take this opportunity of saying that perfect good faith was not kept with those who competed for the Houses of Parliament, for which "Elizabethan" was to be the style followed; yet most assuredly the design chosen did not—however much better it might be—at all answer to that name; whereas one or two others not only really did so, but possessed more than ordinary artistic merit, therefore were morally entitled to preference as having complied with the letter of the conditions. How Elizabethan came to be fixed upon as the most suitable style for the occasion has never been explained; for if its character is non-ecclesiastical, and so far appropriate to a structure intended for a secular purpose, it has too much of the domestic in its physiognomy. Certain it is that the majority of the competitors interpreted the term "Elizabethan" with considerable freedom, and very differently also; and, as it afterward turned out, they had been put upon a wrong scent by it. One thing of which they could not have entertained the slightest idea, was the prodigious latitude that has since been granted with respect to the important matter of *£. s. d.*

A sum ought to be named, if not as the ultimate limit of expenditure, as some sort of guidance to architects, in order that they might know if they were keeping within decent bounds. On the other hand, hypothetical estimates for works of extraordinary magnitude, ought to be received with great caution, more especially if a show of such scrupulous exactness is made that the estimate professes to be calculated to the fraction of a pound—computation no less farcical than fallacious. In the present case of the intended Government Offices, nothing is said as to cost; as to which, as well as to style, complete *carte blanche* seems to be granted to the competitors.

THE ARCHITECTURAL ASSOCIATION.

We are afraid we have laid ourselves open to the charge of remissness in not more frequently bringing before the attention of the profession, and its younger members especially, this important institution. Its origin has now become a matter of history, dating back as far as the year 1842, since which time, if its course has not been always evenly prosperous, it has been marked by recurring proofs of a beneficial influence. The Architectural Exhibition, too, owes its origin to this society; and, if there were no other motive, this alone should stimulate all well wishers to our art-profession to kindly co-operation in return. The elders in practice have many ways in which they could bring forward those embarking in the profession, if they would; but it has always been a stigma among those engaged in what is known as, and it ought to be truly, a liberal art, that they appear to shun each other's society and mutual intercourse in an unworthy and unaccountable manner. Notwithstanding all that the Institute professes to aim at, and in part accomplishes, this barrier is not thrown down: a cool and stately reserve is too evident in their assemblies; far different from what we are accustomed to see manifested in those of their brethren, the engineers; or, indeed, most other bodies. Among the Architectural Association, too, we have reason to know that this exclusiveness is discountenanced, and this is no doubt one great source of its usefulness. Its members, the majority of whom are just entering on their career, meet statedly for the reading of papers, and discussions thereon,—not necessarily in polished, rounded, sentences, but such as have the better recommendation of being dictated by common sense, so that they strike at once at the root of a question. Many of the papers read have, however,

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evinced no ordinary degree of talent, and must have cost much time and thought in their preparation; yet this is not to be deplored, since though it be far more consonant with our indulgent natures to allow others to labour while we are content to enter into those labours, it is well known that the mere necessity (call it drudgery if you will) of hunting up materials and comparing opinions is of infinite service in storing the memory, and training the mind to habits of patient study and inquiry. We are, therefore, well pleased to see the suggestive list of subjects which the committee issued to guide those who may be disposed to turn their attention to some field of investigation during the recess, and we trust in the forthcoming session the fruits of such research will spring up and be abundant. If a tithe only of the members take the matter in hand, the thing will be done; and this will obviate *viva voce* discussions on unpremeditated subjects, which we see are alluded to as a resource, but the utility of which must be secondary to such as have had the advantage of previous consideration.

Another feature of the Association, which we learn has been carried out with encouraging results, is a class for sketching, which is accustomed to meet on the alternate evenings, and when each individual commits to paper his idea or design for some architectural subject *then and there* decided on; these are afterwards collected and examined by the president of the class, and the members generally, who are invited to interchange their remarks; the sketches are also exhibited at the ensuing ordinary meeting. It will be at once evident how mutually serviceable such a class must be under judicious management, how it will tend to elicit ideas, to perfect them, and keep them in control.

The great desideratum in this society is a library for either the circulation of professional works or for reference, and it may excite surprise that no such facility is afforded. But the notorious expense attending architectural publications must be borne in mind, since the better class only would be available—those of less pretension, and periodicals, being for the most part already in the hands of every student. It is in this particular, especially, that the advantage of a connection with the Institute would be apparent. This latter body has a most extensive and valuable collection of books, to which additions are constantly being made; and, as the offer has been made by the senior to the junior institution of an amalgamation of efforts, we are not sure that it would not be found an advisable measure for both parties. Judging from reported discussions, it would appear that the Association are fearful that, in such an event, they would be sacrificing their indepen dence of action and expression, two points to which they mainly attribute their past healthiness and vigour; and were this result, or even a compromise, inevitable, far be it from us to urge the union; but, deeming both parties to be actuated by a desire for their common weal, it can hardly be questioned that such a scheme of operations might be devised as will meet the requirements of each, and subserve the common interests of both. It behoves the Association, then, not hastily to reject the proposition. Of course the question will be speedily brought forward for consideration, as the new session is to commence on Friday next, the 3rd instant, when the President, Mr. Arthur Allom, is expected to deliver the opening address, and to which meeting all interested in the objects of the Association are invited and welcomed.

DECAY AND PRESERVATION OF STONEWORK.

Stone edifices prematurely exhibiting decay,—monuments proving mutable as mortality,—the work of the sculptor, the stonemason, and the architect, destroyed by the cankering hand of time, the effects of gaseous atmosphere, and the influences of damp, have long demonstrated how great has been the want of some means by which stonework can be strengthened, rendered impervious to outward influences, and permanently preserved. Many attempts have been made to effect so important an object; the subject has been discussed at the Royal Institute of Architects, and in several scientific societies, but no successful panacea was brought forward to remove the evil, until the discovery of a stone-preserving process, that has been successfully applied to the exterior surface of the New Palace of Westminster, the nature of which it is our intention to describe.

Mr. Daines, the patentee of this invention, in his provisional specification of August 12, 1854, says:—

"The chief object of this invention is to impart to the exterior surfaces of stone and compo buildings the power of resisting the destructive effects of the atmosphere and of damp. To this end, when operating upon a porous stone or cement, I first apply a solution of sulphate of zinc, or a solution of alum, or other suitable inorganic body, and thereby fill the pores and neutralise the tendency to alkaline efflorescence. I then, by the aid of a brush, or by means of an exhausted case applied to the wall of the building, coat the prepared surface with a cold solution of sulphur, obtained by the use of linseed oil or other suitable solvent, not incompatible (like acids) with the nature of the material under treatment, and the stone or other material will then be impervious to moisture, and even susceptible of taking a polish if such were desired. This invention, it will be understood, is applicable to the preservation from decay, and also to the embellishment, of a variety of articles composed of stone, plaster, or cement, as well as the interior walls and floors and ceilings of buildings."

In his complete specification, of April 19, 1856, he enters into further particulars, and states:—

"This invention relates to a certain mode of treating the surfaces of stone, brick, and composition buildings, for the purpose of enabling them to resist the destructive effects of the atmosphere and of damp, and thus preserving the same from decay. To produce these results I employ a solution of one part by weight of sublimed sulphur in eight parts of linseed or other oil. These ingredients are placed in an earthen vessel, and heated in a sand bath to a temperature of 226° to 278° Fah., when the sulphur is dissolved. This solution when cold is to be laid on the surface of buildings or building materials by means of a brush or other suitable means. What I claim under the above in past recited letters patent is, the use of a solution of sulphur in linseed or other oil, prepared substantially in the mode described, and applied to the purposes specified."

It appears that before this complete specification was ordered to be filed, the experimental trial had been going on to the extent of 1400 square yards of the New Palace of Westminster, the successful results of which are thus attested by Sir Charles Barry, who says in a letter to the patentee:—

"I have carefully examined the three portions of the external masonry of the New Palace of Westminster, which were covered with your stone preservative solution about two years since, and I have the pleasure to inform you that I have reason to be perfectly satisfied with the efficiency of the solution with reference to the object of its application. It seems to have checked all efflorescence arising from exudation from within the body of the stone, and all vegetation on the surface due to atmospheric influences. The absorbent properties of the stone, which are mainly the cause of all decomposition in that material, are to a considerable extent obviated by the indurated coating on its surface produced by your solution, which is so hard as not to yield freely to the stroke of a chisel, and even to be capable to a certain extent of bearing a polish. In those portions of the stone where symptoms of decay existed at the time of the application of your solution, no signs whatever of decomposition now appear, nor indeed in any portion of the surface of the stone subjected to your process. Where in one instance your solution was applied to stone which had long been exposed to the atmosphere, and had acquired a considerable amount of its filth and impurities, a dark and disagreeable colour is the consequence, but where, as in the other instance, it was applied to newly-faced stonework, or such as was not in a filthy state, the colour is by no means objectionable."

Mr. Herapath of Bristol has also, in a letter to the patentee, dated September 8th, said:—

"I am acquainted with the nature of Daines's patented composition for preserving stone, and having inspected on the 5th instant the parts of the New Houses of Parliament upon which it has been tried, I give it as my decided opinion that it will be found efficacious in protecting stone from being destroyed by atmospheric influences, the benefit being the greatest on the most porous and brittle stones. It will also arrest disintegration where it has already begun."

The government authorities having adopted the views pressed upon their notice by Lord Lyndhurst, as to the employment of the solution for stopping the incipient decay of the stone used at the New Houses of Parliament and preventing future decay, workmen are already employed on the walls in other parts of the building besides the 1400 yards on which it was originally tested, so that the whole edifice will be rendered impervious to atmospheric influence and the destructive properties of damp.

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THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

CHELTENHAM MEETING, AUGUST 1856.

(*Continued from p. 303*).

On the Quantity of Heat developed by Water when violently agitated.

By GEORGE RENNIE, F.R.S.

Our knowledge of the mechanical properties of heat has been greatly advanced since the year 1798, when Count Rumford published his valuable paper on the source of heat excited by friction. The investigations of Dr. Black, and subsequently of Watt, Southern, Creighton, and Murdock, of the Soho school, and of Lavoisier, Mongolfier, Dulong, Seguin, and Mayer, have been engaged in similar researches; while the chemical, or rather mechanical properties of heat, have been largely augmented by the researches of Kirwan, Dalton, Leslie, Taylor, Davy, Faraday, Andrews, Graham, Hesse, and Thomson.

1st, the effects of electric action in decomposing or separating compound bodies; 2ndly, the effect of compression and extension in developing heat by solids; 3rdly, the effects of the chemical affinity of acids, and metallic or saline bases; 4thly, the effects of spontaneous combustion of metals and gases, and of oils and fibrous substances; 5thly, the condensation and expansion of fluids and gases, have all been the objects of minute attention by modern philosophers and by those who have contributed largely to this department of knowledge, such as Andrews, Graham, Joule, and Rankine; and by M. Regnault, whose magnificent experiments undertaken under the auspices of the French government, for the purpose of determining numerically the laws which enter into the calculations of steam-engines, have thrown a new light upon the subject. These new values are detailed in the report of M. Regnault, published in 1847, and that able philosopher gives us reason to expect ere long the results of his further researches. But it is to the valuable experiments of M. Joule, communicated to the British Association in 1847 and 1848, and afterwards to the Royal Society in 1849, that we became first acquainted with the numerical value of heat as a mechanical power. These experiments were made on three dissimilar fluids: water, mercury, and oil—and in all three cases the remarkable result appeared that the mechanical power represented by the force necessary to raise 774·881b. 1 foot high, produced a quantity of heat equal to raise the temperature of 1 lb. of water 1° of Fah. This equivalent was afterwards altered by an improvement in the apparatus with which he experimented, to 711 lb., thus confirming the experiments of Rumford and Davy on the friction of solids, and proving that the heat of elastic fluids consists simply in the *vis viva* of their particles.

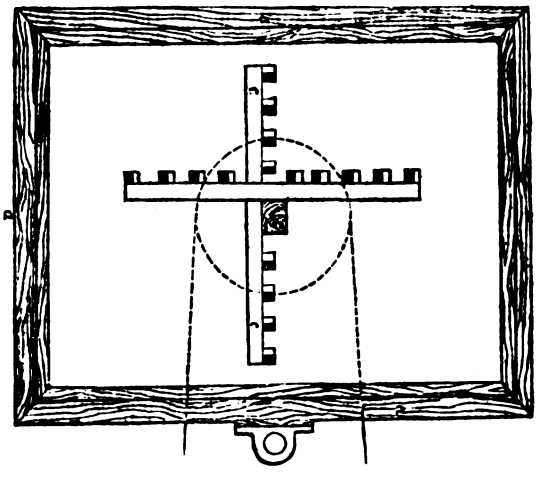
When in 1845 and 1847 M. Joule employed a paddle-wheel to produce fluid friction, he obtained equivalents of 781·5, 782·1, and 787·6 respectively, from the agitation of water, sperm oil, and mercury. These and other experiments left no doubt on his mind as to the existence of an equivalent relation between force and heat. The care bestowed upon these experiments, in deducting the retarding influences, entitle them to every credit. Upon examining M. Joule's tables, it does not appear that the temperature of the water had been raised more than 0·563209°, say half a degree to 97470·2 grains, or as 1° to 7·84229 lbs. of water, or to a higher temperature in mercury. It is desirable, therefore, that these experiments should be extended.

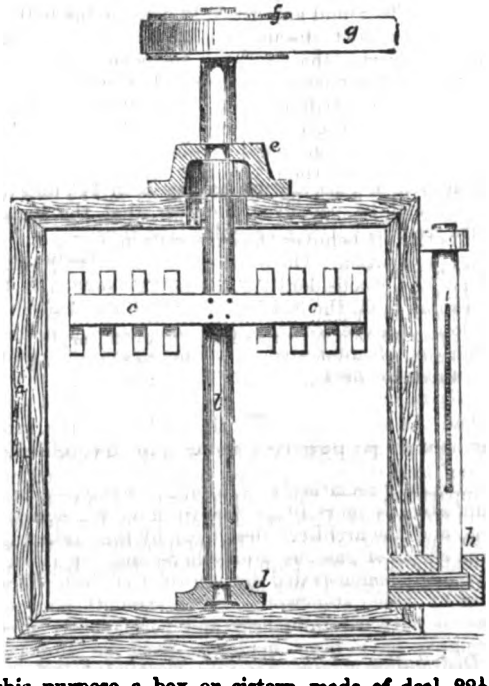
Having long entertained the idea that steam, as applied to the movement of engines, lost a large portion of its heat by transmission, the author watched carefully the attempts which have hitherto been made by inventors for the direct application of heat, or caloric transmitted through air for producing motion: viz., of Neipce, in France, in 1806; of Sir George Cayley, in 1807 and 1838; of Stirling, in 1816; of Ericsson, in 1826 and 1830; and the beautiful contrivances of the combined steam and ether-engine of Du Trembley gave reason to expect that the loss of heat occasioned by the use of steam, and which has been variously estimated at from $\frac{1}{13}$ to $\frac{1}{15}$ of the heat transmitted, led to the expectation that we should ultimately discover a more suitable medium than steam. All these attempts, with the exception of the ether-engine, have as yet been arrested by the rapid oxidation of the engines.

These statements have been further confirmed by the following tables of M. Siemans:—

	Feet.	Fahrenheit.
Formula of Holtzman, in feet	1227	682
Experiments of Joule	1336	770
Formula of Rankine.	1252	695
For the best Cornish engine of Pambour	148	82
For high-pressure condensing low pressure engine	90·8	50·4
For a good Boulton and Watt's engine	46	25·5

Being lately at Southampton, it occurred to Mr. Rennie to make an experiment on the difference of temperature which might occur between the temperature of the water in the floating basin and the water then running through the sluices of the iron gates of one of the dry docks, for the purpose of letting a vessel out from the dry dock into the basin. The result was a difference of 2° between the temperature of the water in the basin and dry dock. Frequent observations on the increased warmth of the sea in stormy weather, and in water running through mill races, coupled with the observations made at Southampton, induced him to make the following experiments.





For this purpose, a box or cistern, made of deal, 22½ sq. in., and 30 inches deep, was prepared; a quantity of Thames water, about 22 in. in depth, was poured into it, equal to 437½ lb. Into the side of the box was fitted a bent iron tube of 2 in. in diameter, and into the upper part of the bend of the pipe a glass tube was inserted, so that by suspending a glass thermometer in the water contained in the tube the temperature could be easily seen. The box was then covered by a wooden lid so closely fitted as to exclude the surrounding air, and to prevent the loss of water by

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agitation. A wooden spindle, having four arms and twelve vertical agitators, was previously fitted into the lid of the box, as shown by the accompanying drawing, a pulley of wood was fitted to the top of the spindle, and the apparatus was rapidly revolved in the water by being connected with a steam engine.

The annexed illustrations exhibit views of the apparatus, and the accompanying description will make the whole understood.

The experiment commenced on the 19th of June last. The apparatus was then worked for an hour and a half, and the result was the raising of the temperature of the water by agitation from 58° to 64°.

The apparatus, however, got deranged, and the experiments were postponed to the following day. The Thames water was then replaced by clear well water, and the apparatus again adjusted. The quantity of water was 437 lb. The temperature of the air was 65° Fah. when the experiment commenced, and of the water 64° Fah. The apparatus made 270 revolutions per minute, and in 55 minutes raised the temperature of the water from 64° to 73½°, or an increase of 9½° Fah.

The experiments were continued on the third day with well water at 59°, and the temperature of the air 60½°. Apparatus was worked from 10·5 a.m. to 1·5 p.m., when the temperature of the water was raised from 59° to 75¼°, or 16¼° increase in three hours. The apparatus was defective from the slipping of the strap, and only made 140 revolutions instead of 270 revolutions per minute.

The apparatus having been repaired, was again set to work on the 24th June, being the fourth and last day of experimenting. Number of revolutions of apparatus, 240 per minute. Temperature of well water in the box, 59½° Fah. The following were the results:

Time.	Temperature	Time.	Temperature
10·0 a.m.	59½°	11·34 a.m.	75°
15·5	69½	12·0	79
11·0	74	12·8	80
11·30	74	1·0 p.m.	89

Stopped for dinner, one hour, and on starting again at 2 p.m. found that the temperature of the water had fallen to 76°, being a loss of 13°; this, however, was owing to the tube which contained the thermometer being exposed to the influence of the east wind. Engine and apparatus were started again at 2 p.m.:

Time.	Temperature	Time.	Temperature
2·0 p.m.	76°	4·15 p.m.	99
2·5	86	4·45	100
2·15	88	5·0	101¼
3·0	92	5·15	102
3·30	95	5·30 ... (stopped)...	103¼
4·0	97½		

The total increase of temperature having been 44°, and the time 6½ hours. It will be perceived, however, that the increases of temperature seem to follow no regular law, thus—

		Increase per hour.
From 10 a.m. to 11 a.m.		14½° Fah.
,, 11 a.m. to 12 a.m.		5
,, 12 a.m. to 1 p.m.		10
,, 2 p.m. to 3 p.m.	it rose from 76° to 92°, or	16
,, 3 p.m. to 4 p.m	,, 92° to 97½°...	5½
,, 4 p.m. to 5 p.m.	,, 97½ to 101¼...	4
,, 5 p.m. to 5½ p.m.	,, 101¼ to 103¼...	4

So that, had the experiments continued longer, the rate of increase per hour might have been reduced to an equilibrium.

As a proof that the box radiated very little heat, on one occasion the apparatus, after the temperature of the water had been raised from 60° to 103° Fah. was left all night for fourteen hours exposed to the external air. The temperature of the water on the box next morning was found to be 87° Fah., being a loss of 16°, or little more than 1° per hour.

On the Distribution of the Vertical Shearing Stress in Beams. By W. J. MACQUORN RANKINE, C.E., F.R.S.S. Lond. & Edinh., Regius Professor of Civil Engineering and Mechanics in the University of Glasgow.

Although it has long been known that at each vertical transverse section of a loaded beam there is, besides the bending stress, a vertical shearing stress whose total amount is equal to the load supported at the vertical section in question, yet it is only of late years, and especially since the introduction of plate and lattice girders, that engineers have found it necessary in practice to take into consideration that shearing stress in determining the dimensions and proportions of beams; and hitherto their calculations have had reference chiefly to its *total amount*, with little or no regard to its *mode of distribution* in different parts of the same vertical section.

The mathematical principles which regulate the distribution of this kind of stress have been the subject of elaborate investigation by various mathematicians, but they have not hitherto been reduced to a form suitable for easy application to practice. The present paper is designed to supply this want. It does not contain any new theoretical principle, neither do its results constitute a theoretically complete and exact solution of the problem of the distribution of stress amongst the particles of a beam; but it gives rules and formulæ by which the vertical shearing stress at any point (being the stress next in point of importance to the bending stress), and the result of the combination of that stress with the bending stress, may be computed with a degree of accuracy sufficient for practical purposes. The following is an abstract of the method pursued.

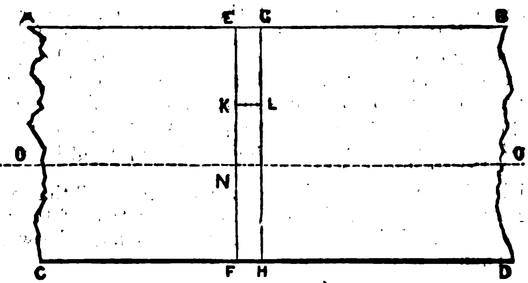

Fig. 1.

The horizontal compressive or tensile stress produced by the bending force at each point in the beam is first to be determined in the usual manner. This having been done, let A B D C (fig. 1) be a side elevation of a portion of the beam, and let it be required to find the intensity, or amount per square inch, of the vertical shearing stress at a point K. Let E K F be a vertical plane passing through K; G L H another vertical plane very near K, the distance between those planes (which may be denoted by dy) being very small as compared with any dimension of the beam. Let K L be a horizontal plane. Compute the total amount of the horizontal stress acting on the portion E K of the plane E F; denote this by h. Compute also the total amount of the horizontal stress acting on the portion G L of the plane G H; denote this by $h + dh$; then the difference, dh, between the horizontal forces so computed must be equal and opposite to the total amount of the tangential or shearing stress on the horizontal plane K L. Let z denote the breadth, or horizontal thickness, of the beam at the point K; then the intensity (denoted by T) of the horizontal shearing stress at K is found with accuracy sufficient for practical purposes by dividing the amount of the shearing stress on the plane K L by the area of that plane: that is to say,

$$T = \frac{dh}{z\,dy} \quad \text{.................................} \quad (1.)$$

Now, according to a principle discovered by Cauchy, the intensities of the shearing stress, at a given point, on two planes at right angles to each other and to the plane of that stress, are equal; therefore the above formula gives the intensity of the vertical shearing stress at the point K of the vertical plane E F, with accuracy sufficient for practical purposes.

Amongst the consequences of the above solution are the following:—

1. Let O O be the neutral surface of the beam, where the horizontal compressive and tensile stresses vanish. The intensity of the shearing stress on any vertical section of the beam, E F, is greatest at the line N, where that section cuts the neutral surface.*

* It will be perceived on the opposite page (333), that an error has crept into equations (2) and (3), in which the maximum and minimum components of the resultant stress should have been R and r, respectively, instead of M and m, as printed. That latter part of the article having been struck off before the first portion, compels us to call attention to it here. Also, at line 26 from top of 1st column, for components read component. Again, the diagram fig. 2, instead of a single line O N O, has a double dotted line carried across it.—ED.

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2. The intensity of the shearing stress diminishes when the distance from the neutral plane increases, and vanishes at the upper and under surfaces of the beam, where the horizontal stresses are greatest.

3. In a beam whose cross section is a rectangle, the intensity of the shearing stress at any point in a given vertical section, varies proportionally to the product of the segments into which the point divides the vertical depth of the section; and the maximum intensity is equal to once-and-a-half the mean intensity; that is, equal to three times the vertical load supported at the given section, divided by twice the area of the section.

The following is a summary of the method pursued in order to find the result of the combination of the shearing stress with the horizontal compression or tension at a given point.

A shearing or tangential stress is well known to be equivalent to the combination of a compressive stress and a tensile stress of equal intensity, acting at right angles to each other, in directions making angles of 45° with that of the shearing stress which is their resultant. When a vertical shearing stress is combined with a horizontal compressive or tensile stress, the resultant stress consists of two components at right angles to each other; the maximum component being of the same kind (compressive or tensile) with the horizontal stress, and acting in a direction making an angle of less than 45° on the side of the horizontal stress next the component of the shearing stress which is of the same kind. The minimum components of the resultant stress is of the opposite kind (tensile or compressive) to the horizontal stress. The following are the formulæ for computing these components and their directions:

Let H be the intensity of the horizontal stress; T that of the shearing stress; R that of the maximum, and r that of the minimum component of the resultant stress; a the angle between R and H. Then

$$M = \sqrt{\frac{H^2}{4} + T^2} + \frac{H}{2} \quad \ldots\ldots\ldots\ldots (2.)$$

$$m = \sqrt{\frac{H^2}{4} + T^2} - \frac{H}{2} \quad \ldots\ldots\ldots\ldots (3.)$$

$$\tan. 2a = \frac{T2}{H} \quad \ldots\ldots\ldots\ldots (4.)$$

The following diagram (fig. 2) illustrates the manner in which the directions and natures of the components of the resultant stress are determined.

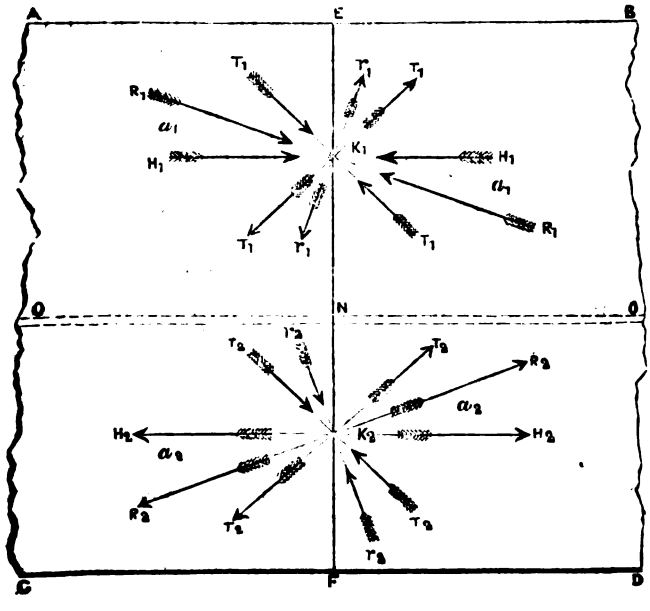

Fig. 2.

ABCD represents a portion of a beam loaded and supported in such a manner that AB is compressed and CD extended, and that the shearing stress at EF consists in a tendency to depress AC relatively to BD. ONO is the neutral surface; K_1 a point in the compressed portion of the beam, and K_2 a point in the extended portion.

Compressive stresses are denoted thus ⟶ ⟵

Tensile stresses are denoted thus ⟵ ⟶

and the letters affixed to the arrows have the meanings already explained.

In the vertical longitudinal section of a loaded beam, a network may be drawn consisting of two sets of *curves of pressure* intersecting each other at right angles, and indicating, at each point of intersection, the directions of the resultant compressive and tensile stress at that point, as found by equation (4). All these curves intersect the neutral surface at angles of 45°.

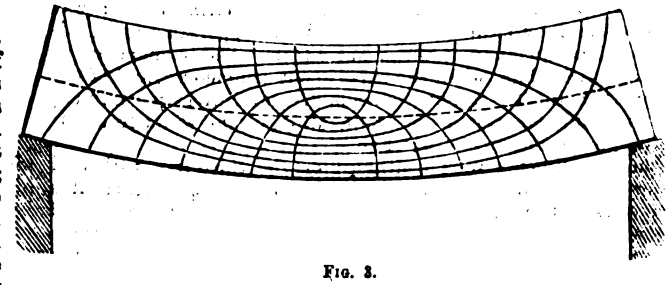

Fig. 3.

Fig. 3 gives a general idea of their arrangement in a beam supported at both ends; the curves of compression being convex upwards, and those of tension convex downwards. The stress which acts along each curve of pressure is a maximum at the horizontal middle portion of the curve, and vanishes at its vertical extremities, except at those points to which the loading and supporting external pressures are directly applied.

The curves of compression are theoretically the best positions for ribs whose object is to stiffen a beam against buckling.

On an Instrument to Illustrate Poinsot's Theory of Rotation.

By J. C. Maxwell.

In studying the rotation of a solid body according to Poinsot's method, we have to consider the successive positions of the instantaneous axis of rotation with reference both to directions fixed in space and axes assumed in the moving body. The paths traced out by the pole of this axis on the *invariable plane* and on the *central ellipsoid* form interesting subjects of mathematical investigation. But, when we attempt to follow with our eye the motion of a rotating body, we find it difficult to determine through what point of the *body* the instantaneous axis passes at any time,—and to determine its path must be still more difficult. I have endeavoured to render visible the path of the instantaneous axis, and to vary the circumstances of motion, by means of a top of the same kind as that used by Mr. Elliott to illustrate precession. The body of the instrument is a hollow cone of wood, rising from a ring, seven inches in diameter and one inch thick. An iron axis, eight inches long, screws into the vertex of the cone. The lower extremity has a point of hard steel, which rests in an agate cup, and forms the support of the instrument. An iron nut, three ounces in weight, is made to screw on the axis, and to be fixed at any point; and in the wooden ring are screwed four bolts, of three ounces, working horizontally, and four bolts, of one ounce, working vertically. On the upper part of the axis is placed a disc of card, on which are drawn four concentric rings. Each ring is divided into four quadrants, which are coloured red, yellow, green, and blue. The spaces between the rings are white. When the top is in motion, it is easy to see in which quadrant the instantaneous axis is at any moment and the distance between it and the axis of the instrument; and we observe:—1. That the instantaneous axis travels in a closed curve, and returns to its original position in the body. 2. That, by working the vertical bolts, we can make the axis of the instrument the centre of this closed curve. It will then be one of the principal axes of inertia. 3. That, by working the nut on the axis, we can make the order of colours either red, yellow, green, blue, or the reverse. When the order of colours is in the *same* direction as the rotation, it indicates that the axis of the instrument is that of *greatest* moment of inertia. 4. That, if we screw the two pairs of opposite horizontal bolts to different distances from the axis, the path of the instantaneous pole will no longer be equidistant from the axis, but will

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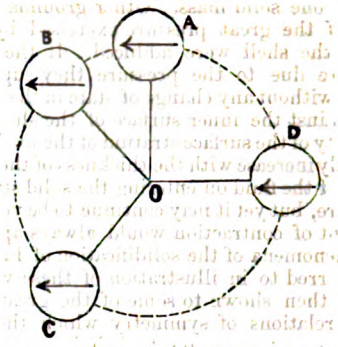
describe an ellipse, whose longer axis is in the direction of the *mean axis* of the instrument. 5. That, if we now make one of the two horizontal axes less and the other greater than the vertical axis, the instantaneous pole will separate from the axis of the instrument, and the axis will incline more and more till the spinning can no longer go on, on account of the obliquity. It is easy to see that, by attending to the laws of motion, we may produce any of the above effects at pleasure, and illustrate many different propositions by means of the same instrument.

Mr. Booth said that the beautiful theory of rotation discovered by the French analysts, and so beautifully given in a condensed memoir by Poinsot, was too universally known to need any explanation. But he was sure that none of the authors of this theory ever anticipated the day when an instrument so simple as the one now exhibited could be produced capable of demonstrating to the eye palpably the most intricate and difficult to be explained of these motions; particularly that of the instantaneous axis of rotation. Mr. Booth then explained that in the case in which this instrument would have run into the room if not caught, the path of the pole of that axis was shown by the theory to be a very elongated elliptic curve. He also pointed out how the theory gave the path of this pole in other cases, and how exactly the instrument illustrated it.

Reasons for Describing the Moon's Motion as a Motion about her Axis. By the Rev. Dr. Whewell.

The moon's motion may be described, in one way among others, by saying that in each month she revolves about the earth nearly in one plane, turning always the same face to the earth. But if a body were rigidly fastened to a rigid radius which revolved about the earth nearly in one plane, such a body would during that revolution turn always the same plane to the earth. Now, would such a body be described as revolving upon its axis during such a revolution? By many persons it would not be so described. But the moon is described by astronomers as revolving about her axis in the course of every month. What are the reasons for such a description? The reasons are briefly these:— 1. The moon is not fastened to the earth rigidly, nor fastened at all. 2. The moon being thus detached, the reference of the moon to the earth as a centre of revolution is arbitrary. 3. The other celestial bodies which revolve about centres also revolve about their axes, and the rule regarding them as not revolving about their axes when they turn always the same face to the centre, would produce confusion: it would, for instance, compel me to say that the earth revolves upon her axis 365¼ times in a year, whereas with regard to the fixed stars she revolves 366¼ times. Also, when a body revolves about a centre turning always the same face to the centre, then is mechanical force required to make it so turn; but no mechanical force is required to make it remain parallel to itself while it revolves round a centre. 1. The moon is *not* fastened to the earth rigidly, as the ancients supposed when they invented the crystalline spheres as the mechanism by which the heavenly bodies revolve, and by which they are connected with one another; and as the body representing the moon is fastened to the body representing the earth in machines made by man. The moon in nature is entirely detached from the sun, and the fact of her turning the same face to the earth does not at all form the machinery of her monthly revolution. Hence it is ascribed to a separate motion, her monthly revolution on her axis, 2. The reference of the moon to the earth is ***arbitrary***. The moon revolves about the earth, but she revolves about the sun also. She revolves about the sun *more* than about the earth; for when she is between the sun and the earth, her face is concave to the sun and convex to the earth's orbit. There are, in some respects, stronger reasons for regarding her as fastened to the sun than as fastened to the earth. But in truth she is not fastened at all; and the simplest way is to regard her as quite detached, and to consider her motion by which she turns her face different ways as quite separate from the motion by which she revolves about any centre. 3. The other celestial bodies also revolve about their axes, and especially the earth. All persons agree in thus expressing the fact in the case of the earth; and as there are 365 days in the year, the earth revolves 365 times on her axis with reference to the sun. By doing this she revolves 366 times on her axis with reference to the fixed stars. 4. It may easily be shown experimentally that mechanical force is requisite in order that a body revolving about another may always turn the same face to the other. The following is one way of doing this. Let a cup containing water be fastened at the extremity of an arm, O A, which revolves in a horizontal plane about the centre, O. The cup will, of course, always turn the same side to the centre O, being forced to do so by the rigid connection of the parts. But



the water in the cup, not having any rigid connection with the centre, will not turn the same side to the centre O, during the revolution of the cup about O. This will appear if a straw be made to float upon the surface of the water; for the straw will always point in the same direction with regard to the surrounding objects (as shown at B, C, and D), and not with regard to O. If the motion is very rapid or long-continued, a slight deviation of the straw from its original position will be produced by the friction of the water against the sides of the cup.

On the Physical Structure of the Earth. By Prof. Hennessy.

After some preliminary observations as to the impossibility of accounting for the earth's figure, without supposing it to have been once a fused mass, the exterior of which has cooled into a solid crust, the process of solidification of the fluid was described. The influence of the connection and circulation of the particles in a heterogeneous fluid was shown to be different from what would take place in a homogeneous fluid such as usually comes under our notice. As the primitive fluid mass of the earth would consist of strata increasing in density from the surface towards the centre, its refrigeration would be that of a heterogeneous fluid, and the process of circulation would be less energetic in going from its surface towards its centre. Thus the earth would ultimately consist of a fluid nucleus inclosed in a spheroidal shell. The increase in thickness in this shell would take place by the solidification of each of the surface strata of the nucleus in succession. If the matter composing the interior of the earth is subjected to the same physical laws as the material of the solid crust coming under our notice, the change of state in the fluid must be accompanied by a diminution of its volume. The contrary hypothesis had been hitherto always assumed in mathematical investigations relative to the form and structure of the earth. The erroneous supposition that the particles of the primitive fluid retained the same positions after the mass had advanced in the process of solidification as they had before the process commenced, had been tacitly or openly assumed in all such inquiries until it was formerly rejected by the author, who proposed to assume for the fluid similar properties to those exhibited by the fusion and solidification of such portions of the solidified crust as are accessible to observation. The results to which the improved hypothesis has led show that it fundamentally affects the whole question, not only of the shape and internal structure of the earth, but also of the various actions and reactions taking place between the fluid nucleus and the solid shell. If the process of solidification took place without change of volume in the congelation of the fluid, the strata of the shell would possess the same forms as those of the primitive fluid, and their oblateness would diminish in going from the outer to the inner surface. If the fluid contracts in volume on passing to the solid state, the remaining fluid will tend to assume a more and more oblate figure after the formation of each stratum of the shell. The law of density of the nucleus will not be the same as that of the primitive fluid, but will vary more slowly, and the mass will thus tend towards a state of homogeneity as the radius of the nucleus diminishes by the gradual thickening of the shell. The surface of the nucleus, and consequently the inner surface of the shell, will thus tend to become more oblate after each successive stratum added to the shell by congelation from the nucleus.

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This result combined with another obtained by Mr. Hopkins, proves that so great pressure and friction exist at the surface of contact of the shell and nucleus as to cause both to rotate together nearly as one solid mass. Other grounds for believing in the existence of the great pressure exercised by the nucleus at the surface of the shell were adduced. If the density of the fluid strata were due to the pressure they support, and if the earth solidified without any change of state in the solidifying fluid, the pressure against the inner surface of the shell would be that due to the density of the surface stratum of the nucleus, and would, therefore, rapidly increase with the thickness of the shell. Contraction in volume of the fluid on entering the solid state would diminish this pressure, but yet it may continue to be very considerable, as the co-efficient of contraction would always approach towards unity. The phenomena of the solidification of lava and volcanic bombs were referred to in illustration of these views, and their application was then shown to some of the greatest questions of geology. The relations of symmetry which the researches of M. Elie de Beaumont seem to establish between the great lines of elevation which traverse the surface of the earth appear to Prof. Hennessy far more simply and satisfactorily explained by the expansive tendency of the nucleus which produces the great pressure against the shell than by the collapse and subsidences of the latter. The direction of the forces which would tend to produce a rupture from the purely elevatory action of the pressure referred to would be far more favourable to symmetry than if the shell were undergoing a distortion of shape from collapsing inwards. The nearly spherical shape of the shell would also greatly increase its resistance to forces acting perpendicularly to its surface, so as to cause it to subside, while the action of elevatory forces would not be resisted in the same manner.

On a Collimator for Completing the Adjustments of Reflecting Telescopes. By Prof. STONEY.

This paper described a piece of apparatus designed to render large reflecting telescopes as perfect in their optical arrangements as refractors. In general appearance the new collimator resembles the telescopes made use of by engineers; it differs only so far that provision must be made for illuminating the wires, and that the large achromatic lens should have a focal length f, determined by the equation,

$$\frac{1}{f} = \frac{1}{d} - \frac{1}{F}$$

where F is the vocal length of the telescope to be adjusted, and d is the distance from the centre of the achromatic lens to the cross wires. If this instrument be placed in the usual position of the eye-pieces and the cross wires illuminated, they and the image of them which will be formed may be viewed through its eye-piece, and if the intersections be brought into coincidence by the adjustment of the mirrors, the line from the intersection of the cross wires to the centre of the large lens of the collimator will be the optic axis of the telescope; *i.e.* this ray, after reflection from the small mirror, will, if produced backward, pass through the centre of curvature of the large mirror. A slight addition to the arrangement would ensure that this axis should also pass approximately through the vertex of the large mirror,—but it was supposed that, so far as the optical performance of the telescope is concerned, this would be found a needless refinement if the collimator be employed only to complete adjustments already approximately made by the usual methods, and if the small mirror be properly supported. The experiments which had been made showed that it was of much importance that the support of the small mirror should be very stiff, and the small mirror should be counterpoised at the end of it. The small mirror is usually supported by a single arm placed edgewise, in order that it may intercept but little light; a second bar, also placed edgewise, and forming a small angle with the first, had been found capable of making the arrangement capable of resisting flexure and vibration in a surprising degree, and, as the angle may be reduced so far that both bars can be attached to a slide carrying the eye-pieces, it is also more convenient than the steadying wire which has been sometimes employed. The facility and accuracy offered by the use of this collimator are such, that it was suggested that in some instances it might be desirable to make arrangements for adjusting the telescope after every considerable change of altitude. If the collimator were to be thus frequently employed, a beautiful contrivance made use of by Lord Rosse might with much advantage be adapted to it, by mounting it and one or two of the eye-pieces in a slide so that any one of them could in a moment be brought opposite to the cone of rays. A slide moving on a centre was recommended. Since the tilt of the large mirror will thus become of less importance, we may henceforth admit for its support arrangements which introduce more tilt than those at present in use,—and thus the solution of what now remains as perhaps the most difficult problem of large reflecting telescopes may be much facilitated.

On Dellman's Method of Observing Atmospheric Electricity. By Prof. W. THOMSON.

The author said: "During my recent visit to Creuznach, I became acquainted with Mr. Dellman of that place, who makes meteorological, chiefly electrical, observations for the Prussian government, and I had opportunities of witnessing his method of electrical observation. It consists in using a copper ball about six inches diameter, to carry away an electrical effect from a position about two yards above the roof of his house, depending simply on the atmospheric 'potential' at the point to which the centre of the ball is sent; and it is exactly the method of the 'carrier ball' by which Faraday investigated the atmospheric potential in the neighbourhood of a rubbed stick of shell lac, and other electrified bodies ('Experimental Researches,' Series IX., 1839). The whole process only differs from Faraday's in not employing the carrier ball directly, as the repeller in a coulomb-electrometer, but putting it into communication with the conductors of a separate electrometer of peculiar construction. The collecting part of the apparatus is so simple and easily managed that an amateur could, for a few shillings, set one up on his own house, if at all suitable as regards roof and windows; and, if provided with a suitable electrometer, could make observations in atmospheric electricity with as much ease as thermometric or barometric observations. The electrometer used by Mr. Dellman is of his own construction (described in 'Poggendorff's Annalen,' 1853, Vol. 89, also Vol. 85), and appears to be very satisfactory in its operation. It is, I believe, essentially more accurate and sensitive than Peltier's, and it has a great advantage in affording a very easy and exact method for reducing its indications to absolute measure. I was much struck with the simplicity and excellence of Mr. Dellman's whole system of observation on atmospheric electricity; and it has occurred to me that the Kew Committee might be disposed to adopt it, if determined to carry out electrical observations. When I told Mr. Dellman that I intended to make a suggestion to this effect, he at once offered to have an electrometer, if desired, made under his own care. I wish also to suggest two other modes of observing atmospheric electricity which have occurred to me, as possessing each of them some advantages over any of the systems hitherto followed. In one of these I propose to have an uninsulated cylindrical iron funnel, about 7 inches diameter, fixed to a height of two or three yards above the highest part of the building, and a light moveable continuation (like the telescope funnel of a steamer) of a yard and a half or two yards more, which can be let down or pushed up at pleasure. Insulated by supports at the top of the fixed part of the funnel, I would have a metal stem carrying a ball like Dellman's, standing to such a height that it can be covered by a hinged lid on the top of the moveable joint of the funnel, when the latter is pushed up; and a fine wire fixed to the lower end of the insulated stem, and hanging down, in the axis of the funnel to the electrometer. When the apparatus is not in use, the moveable joint would be kept at the highest, and its lid down, touching the ball so as to keep it uninsulated. To make an observation the lid would be turned up rapidly, and the moveable joint carrying it let down, an operation which could be effected in a few seconds by a suitable mechanism. The electrometer would immediately indicate an inductive electrification simply proportional to the atmospheric potential at the position occupied by the centre of the ball, and would continue to indicate at each instant the actual atmospheric potential, however variable, as long as no sensible electrification or diselectrification has taken place through imperfect insulation or convection by particles of dust or currents of air (probably for a quarter or half of an hour, when care is taken to keep the insulation in good order). This might be the best form of apparatus for making observations in the presence of thunder-clouds. But I think the best possible plan in most respects, if it turns out to

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be practicable, of which I can have little doubt, will be to use, instead of the ordinary fixed insulated conductor with a point, a fixed conductor of similar form, but hollow, and containing within itself an apparatus for making hydrogen, and blowing small soap-bubbles of that gas from a fine tube terminating as nearly as may be in a point, at a height of a few yards in the air. With this arrangement the insulation would only need to be good enough to make the loss of a charge by conduction very slow in comparison with convective loss by the bubbles, and it would be easy to secure against any sensible error from defective insulation. If 100 or 200 bubbles, each $\frac{1}{10}$-inch in diameter, are blown from the top of the conductor per minute, the electrical potential in its interior will very rapidly follow variations of the atmospheric potential, and would be at any instant the same as the mean for the atmosphere during some period of a few minutes preceding. The action of a simple point is (as, I suppose, is generally admitted) essentially unsatisfactory, and as nearly as possible nugatory in its results. I am not aware how flame has been found to succeed, but I should think not well in the circumstances of atmospheric observations, in which it is essentially closed in a lantern; and I cannot see on any theoretical ground how its action in these circumstances can be *perfect*, like that of the soap-bubbles. I intend to make a trial of the practicability of blowing the bubbles; and if it proves satisfactory, there cannot be a doubt of the availability of the system for atmospheric observations."

On the Law of Electrical and Magnetic Force. By Sir W. S. HARRIS.

The author prefaced the exposition of the views he himself had adopted, after a lifetime of experimental research on the subject, by stating that the discovery of the beautiful and comprehensive law of universal gravitation by Newton had predisposed all physical inquirers to entertain the notion that every other force associated with ordinary matter was subject to a similar law. The forces of electricity and magnetism were especially considered as coming under a like law, and a great variety of experimental inquiries were instituted to verify the conjecture. Cavendish, after Opinus, was certainly the first philosopher who investigated experimentally and threw light on this question. This appears by his celebrated paper in the *Philosophical Transactions* for 1772, and likewise by his unpublished manuscripts, which had descended to the Earl of Burlington, and had been placed by that nobleman in the hands of the author; and, he might add in passing, were open to the inspection of any inquirer engaged in these researches, and contained matter of the most important kind. The author then pointed out several well-known and acknowledged truths in these sciences which were due to the researches of Cavendish. He then pointed out the influence which the researches of Coulomb had exercised on the universal philosophic world, particularly after the writings of the celebrated Poisson, Laplace, Biot, and others, had given form and currency to these views and principles. Such a galaxy of eminent names, and so wide a reception of Coulomb's theoretical views, the author considered to be calculated to discountenance and discourage much critical inquiry as to their soundness, and to immerse us in a kind of philosophical orthodoxy very unfavourable to a more complete knowledge of these unseen, yet astonishing powers of nature which we daily experience. The author then went on to illustrate the law of the inverse square of the distance as applicable to forces emanating from one central point and to other emanations from a centre, and to point out how far this might safely be relied upon as applicable to the electrical and magnetic forces of attraction and repulsion; and stated that the object of the present communication, which the author submitted with all due diffidence, was to investigate the physical condition under which these forces manifest themselves, what are the general laws of the operation of such forces,—how far we may safely consider them as central forces, such as gravity, or whether they are to be considered more in the light of parallel forces, distinctive in their character and in all their relations to common matter, and in the elementary conditions of their character. He then pointed out one in particular essentially distinctive character of these forces. In gravitation, the attracted body, as far as we can observe, remains in the same physical condition before and during all the changes of distance and force to which the bodies are mutually subjected. But in the electrical and magnetic phenomena of attraction and of repulsion, supposing it in a distinctive sense to exist, the very first step was that the body acted upon had its physical condition changed; and this change again, by a kind of reflex influence, affected what had been the instant before the physical condition of the body producing the change; and thus, during the action and its changes, new physical conditions of both had to be investigated and taken into consideration, if we wish truly to interpret the facts. The author then, with some beautifully-arranged apparatus, proceeded to illustrate, by some striking and well-selected experiments, both electrical and magnetic, the truth and importance of these general views,—and concluded his able memoir by showing with what caution the results of the experiments of Coulomb, with the proof plane and balance of torsion, although in themselves statements of most certain facts, which do and must manifest themselves, should be applied as they have been by mathematicians to establish deductions from theories, the very basis of which assumes the bodies to be in such very different physical conditions from those which, when we duly consider them, obtain in nature during the progress of these very phenomena.

On an Instrument for observing the Vertical Currents in the Atmosphere. By Prof. HENNESSY.

The author said he had been led to devise this instrument when offering an explanation, printed in the "Proceedings of the Royal Irish Academy," of certain abnormal phenomena sometimes observed on the surface of Lough Erne. The instrument is constructed like a common wind-vane, but instead of the fixed tail, a circular disc is placed vertically on an axis passing through the branches of a fork at the tail end. This disc is pierced about half-way between its centre and circumference so as to admit another axle, to the ends of which are firmly attached two light rectangular discs. These discs are always in a horizontal position, whatever may be the position of the circular disc, for each of them has a pendulum attached to its centre by which the centre of gravity is kept considerably below the axle. These discs, therefore, cannot be acted upon by a wind which blows horizontally. The position of the circular disc will thus very clearly show whether any given current has an upward or a downward tendency. The application of this instrument to the study of mountain winds was pointed out, as well as to assist in studying some of the undulatory movements of the atmosphere. In the trials which have been already made with it, Prof. Hennessy stated that it gave satisfactory results. The instrument is, of course, not an anemometer, but simply a kind of universal anemoscope, for it shows both the horizontal and vertical directions of a current.

Model of a Self-Registering Anemometer, designed and constructed by Mr. R. Beckley, of Kew Observatory, Described by Mr. WELSH.

In this model Mr. Beckley has adopted Dr. Robinson's method of measuring the velocity of the wind by the rotation of a system of hemispherical cups,—the direction being indicated by a double wheel-fan like the directing vane at the back of a windmill. A stout tubular support carries the whole of the external part of the instrument, including the measurer of velocity, the direction vane, and a rain-guage. This support is so made that it can be easily adapted to the roof of any building upon which it may be necessary to mount it. All the rotatory parts of the anemometer run upon friction balls. The shaft of the apparatus for measuring the movement of the wind, by means of a diminishing train of wheels, is made to turn a cylinder, upon which is wrapped a sheet of paper of the kind used for "metallic memorandum books," this paper having the property of receiving a trace from a style of brass. The sheet of paper is divided into two sections, upon one of which is recorded the motion of the wind and upon the other the direction. As the cylinder is being turned by the action of the wind a clock carries a pencil along the cylinder at a uniform rate of twelve inches in the twenty-four hours. To the lower end of the direction shaft is attached a spiral of such a figure that equal angles correspond to equal increments of radius; the edge of this spiral consists of a thin slip of brass, which touches the paper and records the direction of the wind on a rectilinear scale. When the sheet of paper is unwrapped from the cylinder after twenty-four hours, the motion of the wind and the direction are both found projected in rectangular co-ordinates. The author also stated that as it was well known to

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be difficult, if not impossible, by any method at present in use to judge of the true direction of the wind when in a ship moving swiftly at sea, the method suggested in the following extract of a letter will be found effectual:

"By means of a portable Robinson's anemometer, provided with a means of observing the total number of turns made by the rotating part in any given time, observe the *apparent* velocity of the wind and record it in knots per hour. By an anemoscope of any kind register the *apparent* direction of the wind. From the log-book take the rate and direction of the ship's motion. On a slate or other similar surface *scratch* a permanent compass circle. Set off from the centre of the circle, or the radius of the direction of the ship's head, by any convenient scale, the number of knots per hour the ship is going—from this point draw a pencil line parallel to the direction of the wind as observed by the anemoscope (*i.e.*, the *apparent* direction *to* which the wind is *going*—set off on this line the number of knots per hour as shown by the anemometer—draw a line from the centre of the circle to this last point. The length of this line by the scale adopted gives the *true* velocity of the wind, and its direction (carried backwards) shows the point *from* which the wind is *coming*. A parallel ruler divided on the edge is all that is required besides the slate. It would be easy enough to contrive some mechanism to save the trouble of drawing lines, but it would not, I believe, be any real simplification, and would increase the expense. The train of indicating wheels might be so arranged that they at once indicate knots per hour without reference to tables, and can be readily set to zero for a fresh observation."

Thermometer for Measuring Fluctuations of Temperature, by B. Stewart. Communicated and Designed by Mr. WELSH.

If a bulb be blown between two thermometric glass tubes of unequal bores, and the instrument be filled with mercury in the same manner as an ordinary thermometer, and laid horizontal or nearly so, it will be found that contractions from cold take place only in the narrow bore, and expansion from heat only in the wide one. The reason of this seems to be, that while the temperature remains the same the mercury is kept at rest, and prevented from retreating from the small bore into the bulb, by friction; but, when a motive force is supplied by a change of temperature, the motion of the mercury takes place in that direction in which it is most aided by capillary action. It was suggested by Mr. Welsh to the author that such an instrument might be used to measure fluctuations of temperature. And the author thinks it might be applied to measure with exactness the power of a source of radiant heat; for, by alternately interposing a screen between this instrument and the source of heat, and withdrawing the same screen, the effect of the source on the mercury would be multiplied by the number of times this operation was performed. In constructing such an instrument care must be taken that the tubes used are quite free from dirt or moisture, and that they are not bent, but form one straight line, the bulb being in the middle, and swelling out symmetrically from both its extremities. The best proportion between the capacities of the bores is perhaps about 1 to 4, and the best arrangement of bores seems to be one suggested by Mr. Welsh, viz.—a round bore for the wide tube and a flat or elliptical bore for the narrow one, the greatest diameter of which equals the diameter of the wide bore. In graduating, if, when the instrument is vertical, the narrow bore being beneath, the mercury fills the bulb and rises in the wide bore, then the wide bore may be pointed off at different temperatures like an ordinary thermometer; but if under these circumstances the mercury does not rise in the wide bore, then, in order to point off the wide bore, the instrument must be laid horizontally in a dish of water, and compared with a standard thermometer at different temperatures; the extremity of the mercury in the narrow bore being always kept at a fixed point. When the wide bore has been pointed off we may, by running the mercury along, find what length of the narrow bore corresponds to a certain length of the wide one, and thus be enabled to point off the narrow bore. In using the instrument it should be kept nearly horizontal, and there is probably for each instrument a small range of inclination for every position within which its peculiar action holds, but beyond which it is interfered with by gravity. Before graduating such an instrument it should be ascertained whether it is likely to answer, and the best test seems to be to lay it horizontal, exposing it to changes of temperature of the same nature with those which it is intended afterwards to measure;—if its action be perfect, the mercury will eventually be found to have retreated into the bulb from the narrow bore; but, should it have stopped at any point, the action will only be perfect up to that point. If this demands too much time, it may be tested by repeatedly applying to the bulb of an instrument so placed a few drops of slightly warmed water.

New Method of Making Maximum Self-Registering Thermometers. By Prof. PHILLIPS.

Thermometers constructed after this plan were first exhibited by Prof. Phillips, accompanied by a description, to the Oxford meeting of the Association in 1832. In consequence of a careful examination of the principle on which they were arranged by Mr. Welsh, attention was again called to the subject. The principle of the instrument is the employment of a little portion of the column of mercury, detached as a *marker*. This is capable of a great range of adaptation, and is independent of change by time or chemical action, and as delicate in operation and as free from error as the best ordinary thermometer can be made. Mr. Welsh constructed some in a manner much superior to that formerly employed by Prof. Phillips, and reported in very favourable terms on the accuracy and permanency of the instrument. Thus encouraged, Mr. Casella had undertaken to adapt the thermometer to different purposes in meteorology and philosophical research, but without changing in any degree the essential character of the instrument. Among the examples on the table was one which was planned by Prof. Phillips for special researches on limited sources, or areas, of heat, with small bulb, fine bore, and *short detached marking column*. Thus made, the thermometer may be used in any position, vertical, inclined, or horizontal, and the *short detached marking column* will retain its place with such firmness that instruments may even be carried far or agitated much without losing the registration.

Instructions for the graduation of Boiling-Point Thermometers, intended for the Measurement of Heights. By Mr. WELSH.

Let the thermometer be in the first instance filled with a sufficient quantity of mercury to allow the point 82° Fah. to be where the point 212° is desired ultimately to be. Let a chamber be made at the top of the tube about three inches above the point 212°,—or, if the thermometer is required to have a chamber at the top when finally completed, let there be two chambers made with sufficient space between them to allow of the tube being there sealed by a blow-pipe flame. By comparison with a standard thermometer, set off the points 82°, 72°, 62°, 52°, 42°, (but not 32°). The scale may then be divided, adopting the mark, 82 as corresponding to 212·00; 72 to 201·87; 62 to 191·74; 52 to 181·61; 42 to 171·48. The *graduation* of the scale should then be verified by comparison with a standard thermometer at different points from 37° to 87° Fahr., and a table of errors of *graduation* thus obtained. A sufficient quantity of mercury must now be separated from the main mass until the top of the column stands in boiling water at the proper reading. The superfluous mercury having been lodged in the upper chamber may be removed by sealing up the tube between the two chambers. If it is not possible to detach exactly the proper quantity of mercury to make the column stand at the true temperature of boiling water, the difference should be added as a further constant correction to the table already found by comparison with the standard. The following determination of the corrections to a thermometer, constructed on this principle by Messrs. Negretti and Zambra, will serve as an example of the accuracy which may be obtained by this method:—

Reading of Standard.	Reading of Boiling-Point Thermometer.		Standard Reading after Withdrawal of Mercury.	Final Correction.
	Observed.	Including Final Error at 212°		
42·00	171·76	171·61	171·48	—·13
47·00	176·80	176·65	176·54	—·11
52·00	181·85	181·70	181·61	—·09
57·00	186·99	186·84	186·67	—·17
62·00	191·97	191·82	191·74	—·08
67·00	196·98	196·83	196·80	—·03
72·00	202·08	201·93	201·87	—·06
77·00	207·19	207·04	207·94	—·10
82·00	212·29	212·14	212·00	—·14

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On the Homolographical Maps of M. Babinet. By Prof. Hennessy.

Prof. Hennessy explained the nature of the new system of maps, invented by M. Babinet, Member of the Institute of France, and referred to a letter which that gentleman had written on the subject to General Sabine. In the new projection all the meridians are ellipses, and the parallels straight lines, whence it follows that the areas included between any two pairs of equidistant meridians are always equal. This property is not possessed by any of the ordinary modes of projection, all of which, more or less, distort the actual configuration of the surface of the globe. This new projection, designated by its author the Homolographical Projection, alone possesses the property of making the areas of the different parts of a map equivalent to similar areas on the surface of a globe. Its value in geography is thus obvious, especially in such cases as those where relations of surface are important, such as the distribution of vegetable and animal life, of population, of races, and, in general, of all questions of physical and statistical geography.

Explorations through the Valley of the Atrato to the Pacific in Search of a Route for a Ship-Canal. by F. M. Kelley.

Several surveying expeditions have been sent by Mr. Kelley into this region, and much valuable information has resulted. But the chief result is the conviction of the feasibility of a ship-canal through the isthmus. The most recent of Mr. Kelley's explorers, Mr. Kennish, proposes to enter the Atrato by the Cano Coquito. The greatest depth on the bar is about 4 feet at low water; the soundings gradually deepen, and become 30 feet within 2 miles, when the depth increases to 47 feet, and is nowhere less up to the Truando. The width varies from a quarter of a mile to 2 miles, and the removal of the bar would allow of the transit of the largest steamers. The confluence of the Truando is about 63 miles from the Gulf, and that river forms the channel of the proposed line for 36 miles. The line then follows the valley of the Nerqua through rock-cutting, and passes the summit by a tunnel of 3¼ miles. It reaches the Pacific through the valley of a small stream, and debouches at Kelley's Inlet. In the valley of the Atrato, 300 miles long and 75 broad, and lying between the Antiochian mountains on the east and the Cordillera of the Andes on the west, rain falls almost daily; which accounts for the immense supply of water in that region. On the Pacific side of the Cordillera there is scarcely any rain for eight months of the year. The greater portion of the rain falling in the Atrato valley is caught above the confluence of the Truando. Fifteen large tributaries and numerous smaller streams fall into the Atrato and contribute to the immense lagoons, which form natural reservoirs and a superabundant store of water throughout the year. There are various cogent reasons for selecting the confluence of the Truando as the best point from whence the passage from the Atrato to the Pacific may be effected. In the first place there is no point of junction with the Atrato by western tributaries so near the level of high water on the Pacific as that of the Truando. It happens to be 9 feet above the Pacific at high water, and it is therefore of sufficient elevation to prevent the Pacific at high water from flowing through the proposed cut into the Atrato; while it is not so high as to cause the current from the Atrato to the Pacific at *low* water to pass through the cut too rapidly. In fact, the elevation of the Truando confluence just preserves a preponderating balance on the side of the Atrato. The Atrato, at the junction of the Salaqui, is only 1 foot above the level of the Pacific at high water; but the dividing ridge is 1063 feet high and 30 miles wide, according to a survey of that route by Mr. Kennish and Mr. Nelson. Should any of the rivers at the mouth of the Atrato be selected, without reference to the height and width of the dividing ridge, it may be observed that the maximum tidal wave in the Pacific being 25 feet and that on the Atlantic only 2 feet, the Pacific at high tide would flow into the Atlantic with a current equal to a head of 11½ feet; and at low water in the Pacific the Atlantic would flow into it with a similar current. In the inlet of the Gulf of Micuel, recently called Darien Harbour, the action of the tide is so strong that H.M. steamship *Virago*, commanded by Capt. Prevost, dragged both anchors ahead, and was only brought up by paying out nearly all her cable. The heights of the tides and the levels of the two oceans have been well established by the recent observations of Col. Tolten in Navy Bay on the Atlantic and in a deep bend of the Bay of Panama on the Pacific. On the Atlantic a consecutive series of thirty-two observations were taken in the months of August and September during the season of calms. On the Pacific two sets of observations were made. The first, during May and June, when fifty-four consecutive tides were observed in a season of calms; and the second in November and December, when fifty-two consecutive tides were observed in a season of light winds. The results do not exactly correspond, and are given in the following table:—

	Pacific.		Atlantic.
	May and June.	Nov. and Dec.	Aug. and Sept.
Greatest rise of tide	17·72	21·30	1·60
Least	7·94	9·70	0·63
Average	12·08	14·10	1·16
Mean tide of Pacific above mean tide of Atlantic	0·759	0·140	
High spring tide of Pacific above high spring tide of Atlantic	9·40	10·12	
Low spring tide of Pacific *below* low spring tide of Atlantic	6·55	9·40	
Mean high tide of Pacific above mean high tide of Atlantic	6·25	6·78	
Mean low tide of Pacific *below* mean low tide of Atlantic	4·73	5·26	
Average rise of spring tides	14·08	17·30	
Average rise of neap tides	9·66	12·40	

These observations make the mean level of the Pacific from 0·14 to 0·75 higher than the mean level of the Atlantic; but this is probably owing only to local circumstances, and it may be assumed that there is no difference in the mean levels of the two oceans. The conclusions arrived at by the successive independent surveys carried out at the expense of Mr. Kelley may be summed up as follows:—First, That the ocean can be united through the Atrato and Truando by a canal without a lock or any other impediment. Second, That while the distance between the oceans by this route is only 131 miles, half that distance is provided by nature with a passage for the largest ships. Third, The remaining distance requires the removal of bars, excavations, and cuttings, presenting no unusual difficulties. Fourth, Harbours requiring but little improvement to render them excellent exist at the termini.

On the Tides of Nova Scotia. By. Prof. Chevallier.

The observations to which reference is made were taken by a tide-guage fixed upon a wharf at the north end of the naval yard at Halifax. The tides there are small in amount, the spring tide rising from 6½ to 9 feet at Halifax, and 8 feet at Sambro Isle, twelve miles south of that place. The tides themselves appear to be quite regular; but in addition to the ordinary tide-wave there occurs a series of undulations succeeding each other at intervals of twenty minutes or half an hour, the difference of elevation and depression rarely exceeding 6 inches, and being usually much less. They are more perceptible near low-water; but occur at all times of tide, and are very distinctly marked upon the curve traced by the self-acting tide-guage. The question to be considered is, what is the cause of these small waves? 1. They do not arise from any influence which the casual swell of the sea might exercise upon the tide guage,—for the rise and fall of one of these waves very seldom takes less time than a quarter of an hour, and often requires half an hour, or even three-quarters of an hour. 2. They do not arise from undulatory motion in the whole waters of the harbour. In order to examine this question, Mr. Edgcumbe Chevallier, the storekeeper in Halifax Dockyard, went to Sambro, ten or twelve miles south of Halifax, and entirely clear of the harbour, and erected on Power Island a temporary guage, with which he took the height of the water every five minutes for the whole day. Having laid off the results in a form similar to that employed with the fixed tide-guage at Halifax, it was found that every irregularity at Halifax was preceded ten or fifteen minutes by a larger irregularity at Sambro. These observations show that the irregular waves do not arise from the peculiar form of harbour at Halifax. 3. At about 60 miles eastward from Halifax, outside Sable Island, the gulf-stream runs in nearly a north-eastern direction with considerable velocity; and, between Sable Island and the land, a counter-current runs in nearly a south-western direction. One of these currents would

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elevate the surface of the sea near the middle of the currents; and such an elevation of the surface over which the tide-wave is propagated might give rise to undulations similar to those observed. I am informed, however, that the undulations in question are observed on the western side of Nova Scotia, to which any effect of these two currents could not extend. 4. Although the tides at Halifax and on the neighbouring coast are small, that part of the ocean is near the indraught of the Bay of Fundy, where the peculiar form of the coast and its position with reference to the great tide-wave of the Atlantic give rise to a local forced tide of excessive magnitude. Such a tide, especially when reverberated from coast to coast in a comparatively narrow inlet, might not improbably give rise to perceptible undulations in a neighbouring part of the sea. If this be the cause, it might be expected that a similar effect should be noticed where a forced tide of the like nature takes place. The Bay of Avranches is a locality of this kind, and the Island of Jersey appeared to be a place where any undulations of the tide might probably be noticed. The extreme difference between high and low-water at St.-Helier's is 42 feet, and the difference of height of the mean high and low-water is 36 feet. On inquiry, I find that about ten years since a tide-guage was fixed at St.-Helier's, but observed only at high-water, when irregularities were observed of the same kind as those noticed at Halifax. This seems to give probability to the opinion that the irregularities observed in the tide at Halifax may be connected with the unusual tides in the Bay of Fundy. But whether they rise from this source, or are to be traced to some great reciprocating motion to which the waters of the Atlantic may be subject, the phenomenon deserves to be studied, as likely to lead to a more extended knowledge of the hydrodynamical conditions of our globe.

Prof. Stevelly remarked, that in the account given by the Astronomer-Royal of the tides round the coast of Ireland, a number of anomalous rises and falls of the water in the course of the day were at some times observed at a place called Courtown, he believed in County Waterford, near Wexford.

On the Resistance experienced by Screw Propellers when driven at High Velocities, and immersed at Different Depths.

By GEORGE RENNIE, F.R.S.

It is now nearly a year since, that the author was invited, by Mr. J. Apsey, a mechanical engineer, to witness some experiments which he proposed making on his premises at Broadwall, Lambeth, on the power of a double-threaded screw propeller, which he stated to have been invented and patented by him, but which had been previously invented and tried by another person.

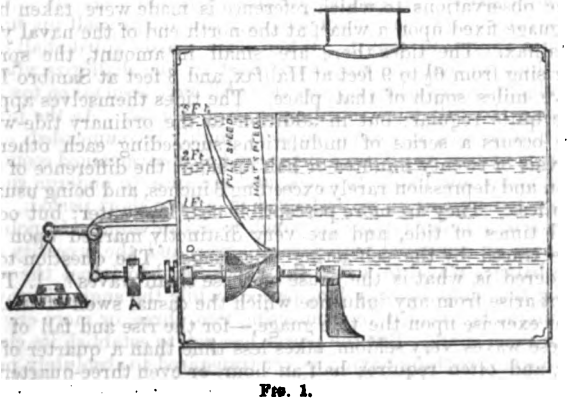

FIG. 1.

The screw, which was fastened on a spindle, as shown in fig. 1, was mounted in an old wagon boiler, 6 feet in length by 4 feet in width, and 4 feet in depth, one end having a pulley fixed to it, and the other supported on a bracket or stand fixed to the bottom of the boiler. The spindle was allowed to work easily through a bush in the bracket, and also through a stuffing-box let into one end of the boiler, so that when the screw was made to revolve, by driving the pulley, it pressed against the water, and then against the arm of a bent lever, which raised a scale with weights accordingly. First, the water was poured into the boiler up to the top part of the screw, and afterwards at the different levels of 1, 2, and 3 feet successively. The screw was driven by a steam-engine, at 920 revolutions per minute. The diameter of screw was 13⅜ inches; the pitch, 7 inches; length, 15 inches; and the end area, 140 square inches. The following were the particulars:

	Weight lifted at 920 revolutions.	Weight lifted at 460 revolutions.
Water level with top of screw...	67 lb.	63 lb.
,, 1 foot above screw	299	88
,, 2 feet above screw	350	112
,, 3 feet above screw	448	126

So that with 920 revolutions, at 1 foot above the level of screw, the increase of pressure was ..... 4·46 times.
At 2 feet above screw ..... 5·22 ,,
At 3 feet above screw ..... 6·66 ,,

While at 460 revolutions, or one-half the speed, the difference was only double between the screw worked with the water on a level with the circumference of the screw, and when the water was 3 feet above it. Thus showing the great effect of working the screw at high velocities.

These results, when shown by Mr. Rennie to the Mechanical Section at Glasgow, in September 1855, were questioned as to their accuracy, on the ground that, being made in a boiler, the water was necessarily confined within the narrow limits of the boiler, and the pressures indicated by the screw uncertain. To obviate these objections, a new apparatus similar to that represented in fig. 2, was constructed in the month of March last, and fixed in the river Thames, opposite to a wharf in Holland-street, Blackfriars.

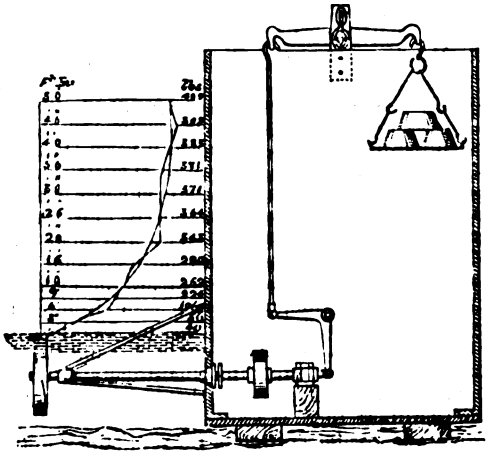

FIG. 2.

The screw-propeller, having two blades similar to the common screw used in government vessels, was fixed on the end of a horizontal spindle, and then driven by a strap connected with a steam-engine at the rate of 558 revolutions per minute, and advantage being taken of the rise and fall of the tides outside the cistern. The screw was driven, when immersed, at different depths, and the following were the results of the different experiments:

	Weight lifted at 558 revolutions.
Water level with the top of screw	40 lb.
,, 1 foot above top of screw	252
,, 2 feet above top of screw	343
,, 3 feet above top of screw	369
,, 4 feet above top of screw	385
,, 5 feet above top of screw	405

Here the differences between the numbers are as follows:—

Between first and second	1·5
Between first and third	1·7
Between first and fourth	1·75
Between first and fifth	1·83

While the numbers are represented by a parabolic curve nearly, thus proving the effects of high speed, when the screw is unfettered by working in a boiler. The conclusions are, that speed is more favourable to developing the power of the screw propeller than depth, and this is more particularly shown by the slight differences of numbers when the screw was working at half-speed in the boiler, as indicated also by the curve. If these experiments be borne out on a larger scale, the inference will be that small light propellers attached to the hollows, or after-run of the sterns of vessels, and worked at high velocities, will be preferable in many respects to large and heavy propellers worked at slow velocities in the dead wood.

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ON THE IGNITION GAS ENGINE.

By T. D. Stetson, Mech. Eng.*

A large engine, working by the direct explosive force of carburetted hydrogen, was exhibited in the New York Crystal Palace, during the fair of the American Institute, last autumn, and at this date remains in the building. By means of a valve, controlled by the operator, the gas was mingled with pretty nearly its combining equivalents of atmospheric air, and exploded in the cylinder; but unlike gunpowder, which, in burning, changes to gas of a permanently greater volume, the combustion of this already rarefied mixture produces a mixture of carbonic acid gas, nitrogen, and water, a change which would increase its mean density except for the high temperature momentarily evolved. The absolute degree of heat developed by the combustion of such mixtures has never been definitely established, but at any estimate between the extremes of 1000° and 5000° Fah., it is sufficient to induce a very considerable increase of pressure. This increase alone is in this engine relied on to impel the piston, and as considerable money has been expended on this device, and some attention has been attracted to it abroad, a few notes of its performance may be placed on record as possessing a negative, if not a positive value.

The inventor and exhibitor of this now neglected machine is Dr. Aifred Drake, of Philadelphia. The diameter of the cylinder is 16 inches, the position horizontal, and the stroke of piston 18 inches. One part of gas is mixed with as nearly as possible 9 parts of air, and the mixture is drawn in at the ordinary atmospheric pressure until about one-third of the stroke is performed. The valve is then allowed to close, and the piston continuing on, immediately uncovers a small recess in the side of the cylinder and allows the mixture to come in contact with a mass of metal at an incandescent heat. An explosion sufficient to produce a sensible concussion follows after the lapse of a very short interval. As may be readily seen, the action of this motor is very changeable in its intensity. How great a pressure is obtained at the moment of the explosion, has never been tested by the indicator or otherwise; but theory would indicate an absolute pressure of from 20 to 100 lb., according as the high or low estimates of temperature be assumed. Whatever the actual maximum heat of the gas, it is evident that it is rapidly diminished by the presence of the metallic surroundings, and the mean pressure may be inferred from the fact that when worked single-acting, it is capable of making about 60 revolutions per minute without load.

These data refer to an exhibition made for the special observation of the writer, as mechanical reporter for the *Tribune*, and being subject to frequent pauses, the experiment extended over a period of two hours. No break or other assistance was applied, nor was the engine worked otherwise than single-acting; the valves at one end of the cylinder being allowed to remain at all times open to the atmosphere.

Although the engine is, as may be inferred, intended to be of sufficient power for practical use, and although it was for a long period in daily exhibition in the same locality, the facilities offered for accurate observations of its results have been extremely limited. The gas employed was from the street mains, the same as used for illumination, and no means were available for measuring the quantity consumed during any given short period. The pressure of the mixture until the closing of the induction valve may be assumed at a very little below the atmospheric, but during the short period intervening between the close of that valve and the explosion, the pressure may be supposed to diminish according to pretty nearly the same law as that of steam. How much should be allowed for the effect of the heat previously contained in the metal? It is probable that the fluid as it flows in through a warm passage, and extends itself upon the interior of the cylinder, becomes heated nearly to the temperature of the latter, or sufficiently to produce a very sensible rarefication. Whether or not this may be held to be of any sensible importance, it is evident that the amount of gas in the cylinder at the period of the explosion, is too inconsiderable to produce the fullest effects possible to realise from such a device.

The method of igniting is one of the principal novel features of the engine, as might be inferred from its name. In previous attempts to work by the direct expansive force of exploding gases, this point has been considered the chief difficulty. An electric spark has been found impracticable; a jet of gas would of course be extinguished at each explosion; and the only available match which seems to remain, is an intensely heated solid. Metal, at a sufficiently bright white heat will ignite gas, and the next remaining questions are,—what metal to employ, where to dispose it, and how to maintain its extraordinary temperature? The mode of igniting adopted by Dr. Drake, in the engine now considered, is to insert a hollow cup of thin cast-iron, and direct into the cavity a constant blow-pipe flame from the outside. The iron is said to retain its integrity several hours, and often days in this situation, a period considerably longer than platinum will endure when heated in contact with this kind of gas. The rapid destruction of platinum when exposed to this agent at a high temperature is a fact pretty generally known, and which has been confirmed by every effort yet made to employ the metal in this engine. The feeble performance described above might probably be much improved by the addition of a compressing pump, which would supply the mixture at a pressure of 40 or 50 lb. per square inch. Thus condensed, the force, at the moment of combustion, would rise to as great an amount as could well be availed of.

The high temperature of the contained fluid must of course convey to the metal a great quantity of heat, and to prevent an injurious accumulation, the cylinder is surrounded by a water jacket. Means are also provided for circulating water through the piston, by making the piston-rod hollow, and connecting thereto a flexible tube. This apparatus was not employed on the occasion referred to, and whether or not these precautions are necessary in practice could not be judged from the short periods during which the engine was allowed to work, which rarely exceeded ten or fifteen consecutive minutes.

Taking a general view of the actual performance, the engine, though failing to work either quietly or efficiently, gives indications that it is possible to impel machinery by this method with a degree of economy exceeding that of steam. I have not calculated the theoretical saving, and it would be of little importance to do so, as it is evident that but a small fraction has yet been utilised. The inventor avers that any hydro-carbon may be employed in the same manner by mixing the vapour with the atmosphere, and he hopes yet to see locomotives crossing the arid plains and barren passes of the Rocky Mountains impelled by a few barrels of camphine alone. Unpromising as the above results may appear, there is little to indicate that it cannot be done.

In one vitally important respect Drake's gas engine differs from those employing aqueous vapour, *i.e.*, the temperature of the cylinders. Steam-engines consume and dissipate heat; this, on the contrary, generates it to a degree supposed to be inconveniently great. A steam cylinder cools and loses its efficacy unless protected by jackets or lagging; this burns itself up, unless water is applied to cool it. When some master spirit shall combine them so that the surplus of heat in one shall give vitality and vigour to the other, a great step will have been taken towards utilising the full mechanical equivalent of heat. As the invention now stands, it cannot be very highly recommended. The power is violent, vacillating, noisy, and of unascertained economy. The igniters are liable to crack, and are sure to undergo such a chemical change as to be destroyed in a very short period. The absence of a boiler tends very much to its advantage in point of lightness as compared with steam-power, and the necessity of a large balance wheel to soften the shocks and to impel the work during the comparatively long periods while the engine is powerless, might be avoided by connecting two, three, or more engines to the same shaft. But the power has yet to establish its claims to efficiency, nothing having as yet transpired to absolutely prove it practically capable of impelling any machinery except its own necessary apparatus.

* From the Journal of the Franklin Institute. June 1856.

Woolwich Arsenal.—The lofty chimney intended to serve the newly-constructed shell foundry here is now completed; it has been carried up to the height of 240 feet from the base.—— Lieut.-Col. Wilmot, superintendent of gun factories in Woolwich Arsenal, has been despatched to Silesia, in West Prussia, to inspect the working of the puddling furnaces there, and to make himself acquainted with the Prussian system of smelting, which is carried out by means of gas, and which, if found superior to our own, is intended to be introduced. Colonel Wilmot is accompanied by Mr. Abel, of the chymical department of the Arsenal.

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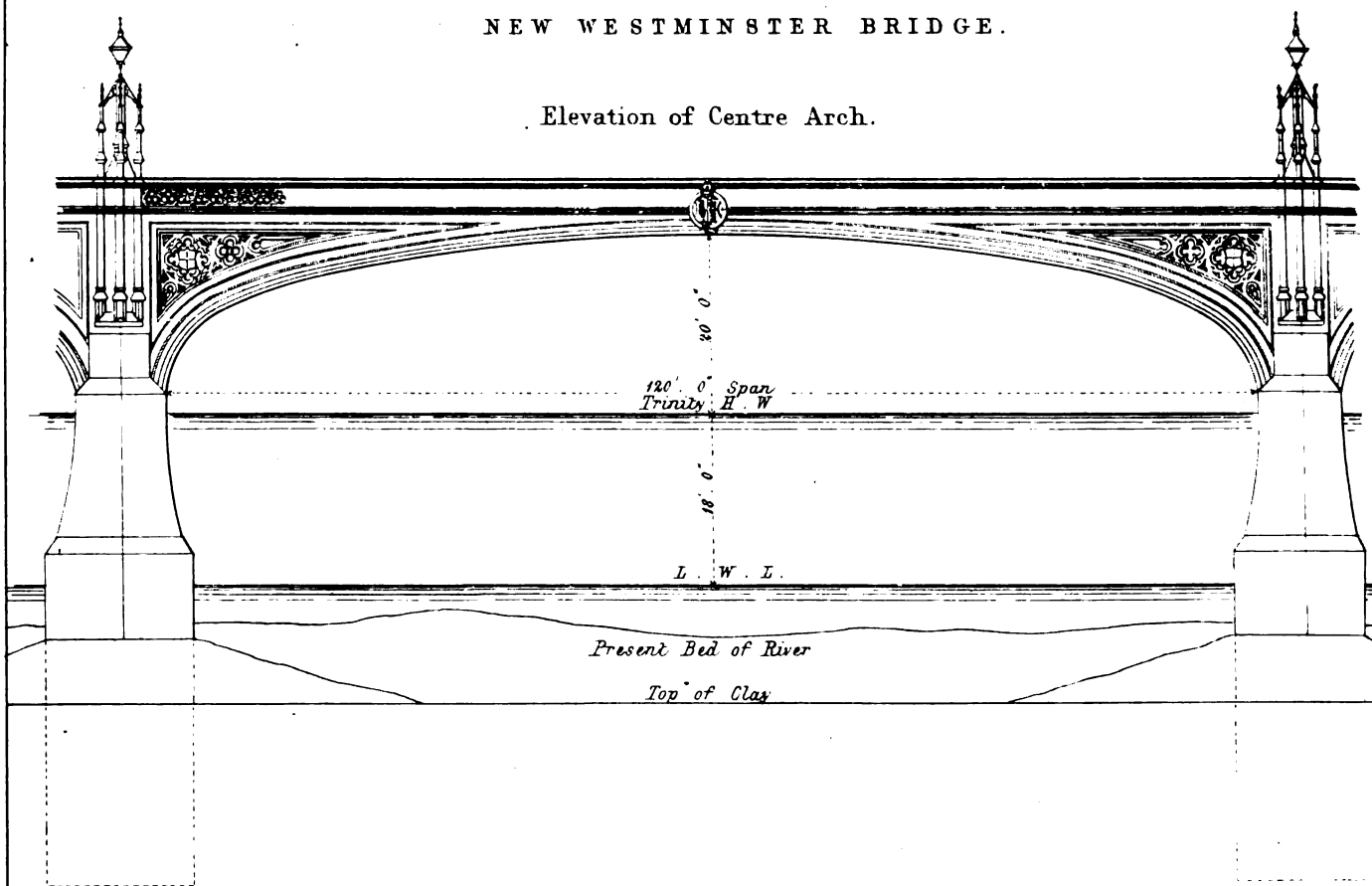
NEW WESTMINSTER BRIDGE.

Elevation of Centre Arch.



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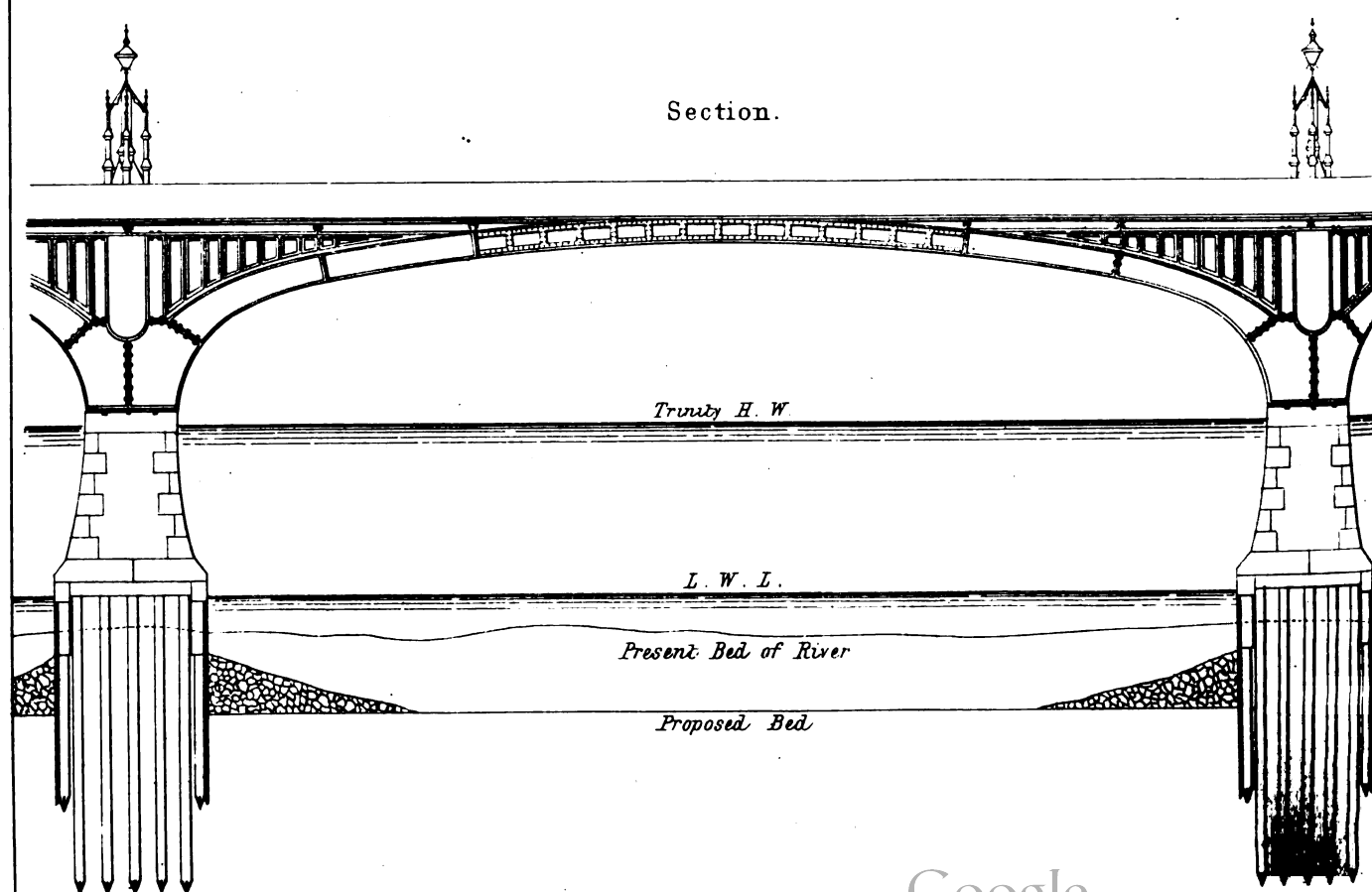

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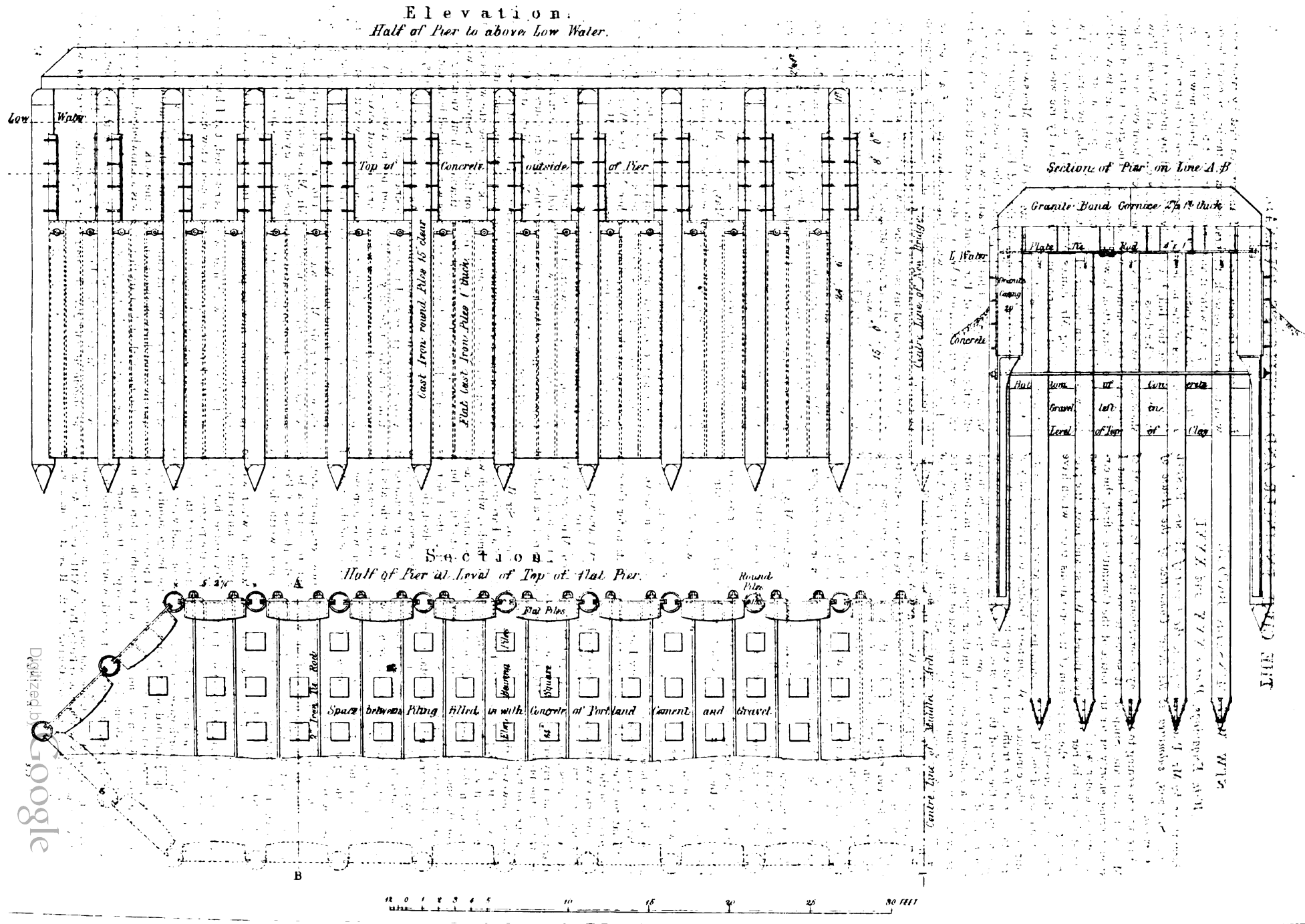
NEW WESTMINSTER BRIDGE.



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NEW WESTMINSTER BRIDGE.

(*With Engravings, Plates* XXX. *and* XXXI).

Observations by Mr. Page, *in reply to the Report of* Messrs. Rendel *and* Simpson, *submitted to the Select Committee of the House of Commons.**

Before proceeding to make my observations in reply to the report of Messrs. Rendel and Simpson, it seems to me to be material that I should bring shortly under the notice of the Committee—first, the circumstances under which the erection of the Westminster Bridge was intrusted to me by her Majesty's Board of Works; and next, the proceedings attending the suspension of the operations there, which have resulted in the present inquiry.

Committees of the House of Commons having at various periods inquired into the condition of Westminster Bridge, the practicability of maintaining it for traffic, and the expediency of constructing a new bridge upon the site of the old one, the Committee of the House of Commons of 1846, reported that, on the evidence which had been laid before them, a sufficient case had, in their opinion, been made out to justify them in recommending the removal of the present bridge, the construction of a new one upon the same site, and the transfer by Act of Parliament of the estates and property of the Bridge Commissioners to the Commissioners of her Majesty's Woods and Works.

Again, in 1850, the Select Committee of that year were instructed "to consider and report specially on the expediency of erecting a permanent bridge on or near the site of the present bridge;" and this inquiry resulted in their recommending the erection, in case of need, of a temporary bridge across the river, and the institution, by her Majesty's Government, of an inquiry for the purpose of ascertaining the most economical mode of building an improved bridge *on* or *near the present site*.

The Commissioners appointed by the Treasury on 20th May, 1851, submitted to their Lordships the following recommendations, viz:—

"That the bridge should be used as a temporary bridge until the new bridge shall have been constructed.

"That the new bridge should be constructed adjoining, or as near as possible to, the present bridge, either on the north or the south side thereof.

"That it should not have more than five arches, which should be of iron, with stone piers.

"That the bridge should not be less than 60 feet in width, that it should have a headway at the centre arch of 25 ft. 6 in. above the high-water standard, called 'Trinity Datum;' and,

"That no time should be lost in making preparations for the commencement of the work."

In conformity with these suggestions, Parliamentary plans were deposited under instructions given to Mr. Hardwick by Lord Seymour as Chief Commissioner, in 1851, and by Lord John Manners to Mr. Hardwick and myself in 1852, in both instances for a bridge to be erected on the present site. My designs, in 1832, were for a bridge of either three or five arches, as might be determined.

When, however, the designs came to be considered by Sir William Molesworth, in 1853, preparatory to being submitted to a Parliamentary Committee, it was recognised as a principle that the bridge, which was to abut upon the Houses of Parliament, should be so arranged as to occasion the smallest possible interference with the effect of those buildings, and it was thought due to Sir Charles Barry that the design, as far as architectural and ornamental character was involved, should be approved by him. As, however, the low levels of the streets leading to the bridge, and the great traffic which would pass over it, rendered it important to limit the elevation above high-water mark to the absolute requirements of the navigation, and to secure the attainment of an easy gradient, the number of arches in the approved design was increased to seven, and the spans of the arches and the thickness of the crown of each arch were reduced in proportion.

This arrangement involved the construction of two extra piers, and, of course, added to the difficulties of the work; but to secure a bridge which would not detract from the appearance of the Houses of Parliament was, in the opinion of the Chief Commissioner, worth the extra difficulties which it entailed.

In the construction of the new bridge, the width of which was to include the site of the old bridge, it was an important consideration not only to avoid the delay and expense of a temporary bridge, but to provide sufficient waterway for the navigation during the progress of the works by avoiding the use of coffer-dams. To this part of the subject Sir William Molesworth gave considerable attention, and when he had decided that the additional width required for the bridge should be set off on the upper or south side of the old bridge, I proposed to construct that part of the bridge first, and to open it for traffic before the main part of the old bridge should be disturbed, excepting those portions of its cutwaters and piers, the removal of which would be required for the foundations of the new piers, and I anticipated that by rapid progress with this part of the work, the first section of the bridge could be completed and opened without any serious detriment to the old structure.

In 1853 the Act passed for the erection of the bridge now in progress. Detailed plans of the mode of construction were not before the Select Committee on this Bill, but I fully explained my intention of erecting it without coffer-dams, and in separate sections, and Messrs. Hawkshaw and Fowler went fully into the subject in their evidence. On both these points the Committee were satisfied. The great points of inquiry before the Committee, however, were the amount of headway and the gradients of the bridge; and although on these points a strong opposition was made on the part of the City of London, by counsel and witnesses, including Mr. James Walker, Mr. Stephen Leach, and others, the principle of construction as then explained by me was not even attempted to be impugned.

On the 19th April, 1854, the late Sir William Molesworth, First Commissioner of her Majesty's Works and Public Buildings, brought under the consideration of the Lords of the Treasury the proceedings which he had thought it his duty to adopt, with a view to carrying into effect the intentions of Parliament in respect to the erection of a new bridge over the Thames at Westminster.

In this letter the reasons which led to the adoption of a headway of 20 feet, and of a bridge of *seven* arches instead of *five*, as recommended by the Treasury Commissioners in 1851, are fully detailed.

After very careful investigations, in which Sir Charles Barry was consulted in regard to the architectural features of the bridge, I completed my design, which was submitted by Sir William Molesworth to the Lords of her Majesty's Treasury, and received their approval.

Working-drawings and specifications were then made out, the quantities ascertained, and advertisements for tenders issued.

My estimate amounted to 224,308*l.*, including a sum of 10 per cent. for contingencies, which, with an addition for dredging and other works, made a total of 235,000*l.* The tender of Messrs Mare and Co., which was 206,438*l.*, was accepted by the First Commissioner of her Majesty's Works, &c., subject to the approval of the Lords of the Treasury, which was given on the 27th of April, 1854, accompanied with authority to take immediate steps to carry the work into effect.

The works were commenced in May, 1854, Messrs. Mare and Co. being under contract, with sufficient securities, to complete them by the 1st of June 1857. The severe winter of 1855, however, having occasioned a complete cessation of work for a considerable period, and some other unforseen delays having arisen, I became satisfied that it would not be prudent to calculate upon the completion of the bridge before Midsummer 1858. On this subject I take leave to refer to my report to the Secretary of the Commissioners of her Majesty's Works and Public Buildings, dated 18th June, 1855, presented to the House of Commons, and ordered to be printed 28th June, 1855.*

In August, 1855, Sir William Molesworth, who had devoted the most anxious and unwearied consideration to the whole questions connected with the bridge, was succeeded by Sir Benjamin Hall as First Commissioner of Works. Soon after this period rumours having reached me of the financial embarrassment of Messrs. Mare and Co., and the possibility of their becoming bankrupts, I brought these under the notice of the First Commissioner on 20th September last, and asked for instructions as to the course to be taken in case the works should be stopped. My instructions in reply, on the 25th September, were "to take such measures as might be practicable without violating the contract." The same day the contractors were rendered bankrupt, but the assignees stated that they did not wish to abandon the works, and they proceeded with them accordingly. As a critical part of the operations were then in progress, I thought it desirable to give them time to ascertain at what rate they could proceed before advising any stringent measures. This emergency was a source of great anxiety to me, and I of course made it my duty to ascertain in what way it could be met, supposing the assignees to be either unable or unwilling to carry on the contract. I found that Mr. Campbell, who throughout had charge of the works for Mr. Mare, was disposed to undertake to proceed with the works upon the terms, generally, of Mr. Mare's contract, under approved securities. I communicated this to the Secretary of the Board of Works, in a letter upon the 27th September, and at the same time laid before him every fact which in my opinion was necessary to guide the Board in its decision how to proceed with the works without violating the contract.

To this letter no written answer was returned, but I had an interview with the First Commissioner on the subject a few days afterwards. On the 12th January I reported on certain bills for extras handed in by Mare's assignees, and stated at considerable length my opinion of what should be done to prevent embarrassment to the Department of Works, and to avoid delay in the execution of the work.

On the 15th of January this letter was acknowledged, and instructions were sent to me by the First Commissioner to prepare myself to give details as to arrangements with other parties for the completion of the works. On the 27th of February I reported the details of such an arrangement, and gave the names of responsible contractors, who were

* See the Report by Messrs. Rendel and Simpson, accompanied by an Engraving of the details of one pier of New Westminster Bridge, Plate XXIII, page 272. An abstract of the evidence given before the Select Committee of the House of Commons will be given next month.

* See *Journal*, Vol. XVIII. (1855 p. 277.

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prepared to complete the works for a sum not exceeding my original estimate. These contractors were Messrs. Cochrane, of Woodside, and I pointed out "that if fair arrangements could be made with the assignees of Mr. Mare, it would be to the advantage of Government, both in point of time and expense, to arrange with Messrs. Cochrane for the completion of the work."

In the meantime, viz.—*on the 16th of January*, the Chief Commissioner informed me that he had "directed Mr. Rendel and Mr. Simpson to visit the bridge and report to him fully on all the points in relation to the contract, the nature of the works, and all matters relating thereto, and to advise as to future proceedings."

Except this letter, I had no information from the Department as to the object of Messrs. Rendel and Simpson's inquiry, and from what passed in my communications with these gentlemen, I conceived that it related chiefly to matters connected with the contract. In this conjecture I am borne out by the letter of the First Commissioner to the Lords of the Treasury, of the 23rd of February last, laid before the Committee by Mr. Austin, in which he mentions, that he had that day received the report of Messrs. Rendel and Simpson, "on the whole matter referred to them," and from the terms of the report itself, also produced by Mr. Austin.

On the 20th of March the works were stopped without any previous communication with me, and I immediately informed the First Commissioner of this fact.

The suddenness of this step took me completely by surprise, the more so that it was coupled with a communication from Mr. Campbell, the manager of Mr. Mare, that the First Commissioner had intimated to the assignees that the works might be discontinued at their convenience. It was of consequence to the security of the works, that they should not be suspended until further progress had been made, and I therefore wrote to Mr. Campbell, protesting against the sudden stoppage; and in a letter of the same date to the First Commissioner of Works informed him that I had so written, and stated my reasons.

From that time till now the works have remained suspended.

I beg to refer to the copies of the correspondence in the Appendix to these observations, which will place the Committee in possession of all the facts connected with the stoppage of the works.

It now appears from the evidence of the First Commissioner before the Committee (Ans. 449), that on the 7th of January he was "waited on by a gentleman in whose experience he had great confidence; and who thought it would be better that he (the First Commissioner) should direct his attention very particularly to the state of Westminster Bridge, which he described not to be in a very satisfactory condition." Although the First Commissioner attached so much importance to the statement of his informant, that he considered it necessary instantly to call in the aid of Messrs. Rendel and Simpson, I was not made aware that any doubt existed either in regard to the principle of construction, or to the execution of the works; and until I read the statement of the First Commissioner I had no idea that any such charge had been made. As the engineer responsible both for the plan and execution of the works, and as the engineering adviser of the Board of Works for more than 12 years, may I suggest that it was due to me that I should have been informed of an imputation so serious in its character, having been made against me, and furnished with an immediate opportunity of vindicating my plans and my professional reputation? Instead of this, however, I was not even made aware by the department, of the terms of the instructions given to Messrs. Rendel and Simpson until the report of these gentlemen had been printed for the House of Commons, and the present Committee had been appointed. The Committee is now aware, from the evidence of Mr. Robert Stephenson, Mr. Hawkshaw, and Mr. Fowler—all of whom have minutely inspected the works—that even after a sudden stoppage for four months, they are in a most satisfactory state. It may not, therefore, be thought out of place if I suggest that the informant of the First Commissioner should be called upon by the Committee to state the grounds upon which he cast his slanderous imputation upon my professional character. However little I may rate any communication of such a nature, made in such a way, it seems to me no more than just that I should know my accuser, and that the public should be in a position to estimate what weight should be attached to an attack thus indirectly made, and calculated to affect me most injuriously with the department of which I am the engineer, and with the public, to whom the execution of a work of such importance is necessarily a matter of interest and observation.

I now proceed to make a few observations in reply to those parts of the report of Messrs. Rendel and Simpson, which appear to me to be pertinent to the questions under consideration of the Committee.

In *viva voce* discussion before the Committee, it was difficult to draw from Messrs. Rendel and Simpson such an elucidation of the facts and opinions given in their report as, I am satisfied, would have militated against the conclusions at which they seem to have arrived. I therefore think it right to record in writing my own views of the nature of the construction now in progress for the piers of the New Westminster Bridge in reply to their report.

It will be unnecessary here to consider the first four heads of the subjects referred to in the instructions to the reporters, and I shall confine my observations to the opinions and conclusions they have based on the 5th and 6th heads of the instructions, viz.—

No. 5. An opinion as to the original scheme, and the exact nature of that scheme; and,

No. 6. The desirability of proceeding with it.

General Description of the intended Structure.

The construction of the foundations resembles those of the Chelsea Bridge, which had been approved by the Duke of Somerset (then Lord Seymour), when Chief Commissioner of her Majesty's Woods, after his Grace had caused a careful investigation to be made into the use of the iron facings of such foundations for wharfs, &c., in other localities.

The construction combines all the advantages of foundations on bearing-piles made by means of coffer-dams, without the expense and obstruction to the waterway which they involve, and which would have rendered their use at Westminster Bridge all but impracticable.

Round the bearing-piles a casing of cast-iron piles and plates is driven to an abundant depth into the bed of the river, and tied together and to the timber piles by wrought-iron tie-bolts.

Between the piles the bed of the river is dredged to the hard gravel, and the whole space is filled with concrete, so as to form a solid mass.

In the Westminster Bridge, the piers of which are to have granite facing, the iron plates are stopped at 6 feet below low-water, and granite slabs, 18 to 20 inches thick, are substituted for the plates.

Each pier thus consists of 145 elm bearing-piles, driven on an average 29 ft. 6 in. below low-water line, 44 cast-iron piles 24 ft. 9 in. in length, driven 23 ft. 9 in. below low-water line, and 44 cast-iron sheeting piles, 15 feet in length, driven 21 feet below low-water, surmounted by granite slabs, 8 feet by 5 feet, rising to 2 feet above low-water.

The bearing-piles are thus 22 feet below the average level of the caissons of the old bridge, and the cast-iron piles and plates respectively 16 ft. 9 in. and 14 feet below that level, and taking the level of the bed of the river in the centre of the arches to be dredged and maintained as low as the bed of the river at London Bridge, the lower edges of the plates would be 2 feet below that bed, the iron piles would be 11 ft. 9 in. below it, and the timber bearing-piles 17 feet below it, while at the piers themselves the ground would be 7 feet higher, giving at the piers a depth from the surface of the bed to the edge of the plates of 18 feet.

Fifteen borings were made into the London clay to a depth of 40 feet, and one boring was carried to the depth of 60 feet. Specimens were retained of every foot of these borings, and the clay was found of a uniform and dense character.

In driving the bearing-piles into the clay, the degree of resistance specified for each pile was not attained so soon as was anticipated, which accounts for the additional length of the piles beyond what was specified in the contract, and to obtain a greater area of piled surface, I thought it advisable to increase the number of bearing-piles originally contemplated.

A comparison of the weight of the superstructure and piers upon the piles, and area of the foundations of New Westminster Bridge with that upon the substructure of other metropolitan bridges will be interesting and satisfactory. Supposing the piles themselves to bear the whole weight, the pressure of each pile of Westminster Bridge would be 15 tons, and supposing the weight to be distributed over the surface of ground comprised within the entire line of the iron plates, the pressure would be two tons per foot superficial.

Comparing these pressures with those of the foundations of London Bridge, which structure, from the observations by Sir John Rennie and myself, made for the Corporation of London in 1854, had not moved for the previous twenty years, the results are as follows:—

Pressure on each pile in Westminster Bridge.....15 tons.
Ditto.....London Bridge.....30
Pressure on each foot of ground at Westminster Bridge...2 tons per ft.
Ditto.....London Bridge.....5

And comparing the pressure of the New Bridge with that of the present Westminster Bridge, it results that the pressure under the old bridge is 6 tons, or three times that due to the new structure.

It is admitted by the reporters that my efforts to avoid the cost of a temporary bridge and coffer-dams are laudable; but they object to the mode by which I endeavour to attain this result, and they give a detailed description of my plan, which, however, very imperfectly exhibits the nature of the structure.

Their words are—"That the piers below low-water are formed of a series of wooden piles, surrounded by a sheeting of cast-iron, the space enclosed by this sheeting being filled in with concrete," and they characterise them "as dependent on the combined action of several classes of materials, differing in their strength as well as in the manner in which they are applied."

In my opinion, a fairer idea of this structure would be given in the following terms:—

Considering the manner in which the timber, iron, and concrete, mentioned by the reporters, are used, the piers, from the level of 16 feet below high-water, Trinity datum, must be looked upon as a solid mass of incompressible and indestructible materials, "carried down deep into the London clay," and terminating 48 feet below the level of Trinity

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high-water mark. When I say incompressible and indestructible, I mean, of course, within the ordinary limits which govern all structures.

In proof of my description, I proceed to consider *seriatim* the separate constituents of the pier, and the part they play in its structure.

The elm piles are 14 inches square; they are driven with a ram 1 ton weight, or with a steam ram 1½ ton weight, to a depth of 19 feet into the solid London clay, and 24 feet into the bed of the river.

Supposing these piles to bear the entire weight of the structure, they would be ultimately loaded, as before stated, with a weight of 15 tons each, or 12 tons per square foot in the pile.

The following examples of the loads borne by piles prove that this is an unusually small load for the bearing-piles in foundations:—

	Diameter of Pile.	Loaded with	
		Total.	Per Sq. Foot.
	inches.	tons.	tons.
Neuilly	12	47	47
	12	47	47
Orleans (pine)	12	46½	46½
	12	46½	46½
Hull Docks	10	25	37
London Bridge	—	80	—
Albert Warehouses, Liverpool ...	—	80	—
New Westminster Bridge... ...	14	15	12

It is a well-known fact, that the elm piles would bear, without permanent alteration, a compressive force of 200 tons each. As regards flexure, as they are surrounded by concrete where not in the bed of the river, they cannot be subject to that strain. As regards durability, they will be entirely cased up in materials protecting them from the alternate action of air and water, and in such circumstances timber does not decay; therefore this portion of the pier is incompressible and indestructible.

The concrete deposited round the piles is formed of gravel and Portland cement; it is of a very dense character, its specific gravity being 2·3, that of granite being 2·66. This concrete rests on a dense bed of gravel, overlying the clay; and supposing the concrete surface to bear the total weight of the structure and load, independently of the piles, the pressure on each square foot would not exceed 2-⅕ tons; supposing the weight to be carried by the entire surface of the pier, the pressure would be two tons per foot superficial upon the bed of clay, which is now subject to a pressure of 6 tons per foot superficial under the piers of the old bridge, and to 5-⅕ tons on the foot superficial at London Bridge, as before stated.

The exterior of the pier is a solid and continuous *facing* of cast-iron and granite, closely fitted and bound together, and to the elm piles, with strong wrought-iron tie-bolts. The weight upon the granite, after the bridge has taken its bearing, would be two tons to the square foot; the crushing weight of granite is 5 tons to the square inch, or 700 tons to the square foot.

Each cast-iron guide or main pile (15 inches diameter, the metal being one inch thick) is driven 12 feet into the solid London clay, and, in reference to the load it has to bear, is incapable of further sinking. Suppose, for a moment, that the sheet piles have no effect as bearing-piles in themselves, but depend entirely on the shoulder which supports them in the main piles, we should then have about 12 tons to be supported on each of the main piles, partly on the top and partly on the sides. And if there were the least tendency to flexure under this small weight, it is prevented by the ties, and by the surrounding strata through which the piles are driven. But, in point of fact, the resistance of the sheet piles from friction, and their absolute strength, is so far beyond the weight they have to bear, that they must, in truth, be also looked upon as bearing-piles of great efficiency.

Now, as to durability, it may safely be asserted that, as regards the *mechanical* action of water, or moving materials of the bed of the river, cast-iron is indestructible; as regards its chemical action, we have no data to give cause of alarm, but, on the contrary, the use of this material is largely spreading in hydraulic engineering; and numerous instances may be given where it forms the sole dependence of the heaviest structures in water. From my own observations of it when exposed to the action of water from the bed of gravel over the London clay, and from water in the plastic clays, a deposit of oxide of iron is formed on the surface, which actually protects the iron itself; and Mr. Mallet, who has made experiments in great detail, states that iron coated with purified gas tar will last for ages.

This part of the pier may therefore be fairly considered to be incompressible and indestructible; and, as regards fracture from unexpected causes, the solidity of the castings, ascertained by severe tests, is such as to leave no reasonable ground for apprehension on this score.

I have now shown that there are a sufficient number of points of support, and a strong casing; and it remains to show that the whole is connected and bonded together by a homogeneous mass equally indestructible and incompressible with what has been described, in such manner that no part can act independently, and so that the whole pier must be considered at least as complete and uniform in effect, and as if it were, in the words of the reporters, "a *solid* stone pier founded in the *clay* 38 *feet* below the level of high-water," but with this additional advantage, that the proposed piers are founded 19 *feet deeper* than the reporters consider sufficient to ensure permanence. A simple inspection of the concrete used, and of the manner in which it is rammed around the piles, and in which it sets and adheres firmly to everything in contact with it, is sufficient to show that the above is a fair and true description of this material, and of the function it performs.

Reasons for Dispensing with the use of Coffer-dams.

If the arguments used up to this point be considered conclusive as to the question of permanency and solidity, it must be obvious that the employment of coffer-dams in the construction of these piers would have been superfluous. So far from agreeing with the reporters that a coffer-dam is "peculiarly required for this mode of construction," I am satisfied that all the parts of the work being exactly guided and confined to their proper form by operations conducted above low water, so that faulty execution in any of them must be immediately detected and corrected, there could be no advantage to the work derived from the use of coffer-dams, except in setting the granite slabs and securing the ends of the lower tier of wrought-iron tie-bolts, which operations are performed under the eye of an experienced inspector with the diving-bell.

It is argued by the reporters that coffer-dams are required for the more efficacious removal of the old bridge and its foundations, but I shall adduce evidence by Mr. Rendel of a contrary opinion; and in this case, the dams cannot possibly apply to anything but the *foundations*, though the *arches* are mentioned. But to apply this principle, and to include both old and new foundations, the dams must have been of extraordinary dimensions. The level of *the old caisson beds is on the gravel*, and no difficulty has been hitherto found in removing portions of them, nor can I see any likely to arise with regard to the remainder beyond that which attends all operations carried on under water, which in reality may now be performed with as much certainty as works above ground. To suggest coffer-dams for removing these foundations, after an offer has been made, as I shall show, by a responsible contractor, to take down all the old bridge and complete the new bridge in two years from the opening of the first portion, is setting mere opinion against all experience.

It must be borne in mind that works executed or repaired by the use of coffer-dams have not always been attended with satisfactory results. I may instance the case of Blackfriars Bridge, which was founded in coffer-dams in 1760, and in consequence of the settlement in some of its piers, was repaired by Messrs. Walker and Burges in 1844, also in coffer-dams. The subsequent failure of this structure, two of its arches being now supported by centering, furnishes a case of the inefficiency of founding and repairing bridges by coffer-dams.

Again, New London Bridge, founded in coffer-dams of great size and strength, was, notwithstanding the excellence of the material and workmanship, subject to a settlement in all its piers, varying from 6 to 10 in. on the down-stream side of the bridge.

Lastly, the piers of Old Westminster Bridge, also repaired by Messrs. Walker and Burges by the use of coffer-dams, which were admirable in their construction, sunk, as the Committee are aware, before the repairs of the bridge were completed.

I must now call attention to the recent and important instances in various countries where engineers, entirely discontinuing the costly apparatus of coffer-dams for founding most important structures, have substituted in many cases, systems similar to, but often far less perfect than, the one I have just described.

On the Continent it has become an almost universal practice, during the last thirty years, to make the foundations of piers of bridges in deep water, by means of a series of timber bearing-piles carried up above the bed of the river near to low-water level (thus forming part of the pier), surrounded by a sheeting of timber (a much more destructible material than cast-iron), the space enclosed by the sheeting being filled in with concrete; and the bed of the river being formed and protected outside the sheeting by rough concrete or loose rockwork round the pier.

In reference to this mode of protecting the bed of the river, I beg to call attention to the simple, inexpensive, and efficient method described to the Committee by Mr. Rendel, as having been adopted by himself under the Lary Bridge at Plymouth about thirty years ago.

The following are a few of the bridges constructed in this manner, since 1824.

1. Concrete cased in timber:

Name of Bridge.	River.
Asnières	Seine.
Carrousel	Ditto.
Cubzac	Dordogne.
Indre	Indre.
Langon	Garonne.
Aiguillon	Ditto.
Souillec	Dordogne.

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2. Bearing-piles and concrete cased in timber:

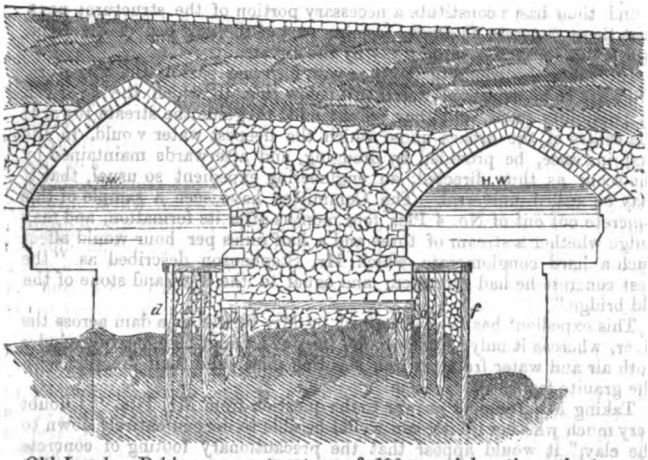
Name of Bridge	River.
Chepstow	Wye.
Marienburg	Nogat.
Dirschau	Vistula.
Wronke	Warthe
Seville	Guadalquiver.

3. Piles and concrete unprotected by casing:

Rouen	Seine.
Jena	Ditto.
Austerlitz	Ditto.
Alma	Ditto.
Victoria	Ditto.

The question of permanence of such foundations has been settled by the experience obtained by the durability of the piers of Old London Bridge, which was really similar in construction to the New Westminster Bridge, although with fewer bearing-piles, and those disposed round the outer edge of the pier. The accompanying engraving represents the construction in which the two rows of triple bearing-piles are marked by the letters *a*, *b*, *c*, and the sections of the starlings are shown by the letters *d*, *e*, *f*. These starlings form the protection to the pier, and are represented in the new piers at Westminster Bridge by the iron sheeting piles and granite slabs.

Section of the Fifth South Pier and Starling of the Old London Bridge.



Old London Bridge was a structure of 600 years' duration; the top of its piles were at the level of the low-water line, and when the bridge was removed, they were drawn out in a sound state. The weight of the houses on the bridge must have thrown a great and unequal pressure on the foundations, and yet the bridge stood in excellent order, although exposed to the scour of the ebb tide, which ran like a rapid under its arches. The state of the piles of the bridge affords a strong confirmation of my views on the durability of the piles of Westminster Bridge at their present level; but to cut them at the level of the low-water in the Pool, as suggested by Mr. Stephenson, can be effected without inconvenience, and it is a suggestion I would willingly adopt.

Instances of employing Cast-Iron as an Outer Casing.

The following are some of the structures in England, Ireland, and elsewhere, in which cast or wrought-iron is employed as a support or outer casing in rivers:

Chepstow Bridge (Brunel)	Cast iron and concrete piers, 60 ft. high.
Windsor Bridge (Brunel)	Cast-iron concrete and cylinders.
Sutton Wash Bridge (Stephenson)	Cast-iron, brickwork, and concrete.
Windsor, Yssel, and many other bridges (Locke & Errington)	Cast-iron, brickwork, and concrete.
Yare Bridge (Bidder)	Cast-iron, brickwork, and concrete.
Two Brigdes at Windsor (Page)	Cast-iron piles, bearing-piles, and concrete.
One bridge at Chelsea (Page)	Bearing-piles, cast-iron sheet and guide piles, and concrete.
Victoria Dock Walls (Bidder)	Cast-iron sheet and guide piles and concrete.
Blackwall Wharf (Bidder)	Cast-iron sheet and guide piles, with concrete.
Rochester Bridge (Cubitt)	Cast-iron and concrete.
Liffey Wharf (Cubitt)	Granite wall on cast-iron piles.
Wye Bridge, Hereford (Liddell & Gordon)	Cast-iron sheet and guide piles, and concrete.
Shannon Bridge (Hemans)	Cast-iron, filled with rubble masonry.
Wexford Pier (T. Clarke)	Cast-iron columns.
Gravesend Pier (T. Clarke)	Cast-iron columns.
Gravesend Girder Pier (Redman)	Cast-iron columns and concrete.

Besides these, there might be quoted numerous light-houses, in the most exposed situations, of cast-iron in various forms.

The above instances surely afford overwhelming evidence that coffer-dams may be abandoned without danger to the structure; that structures, founded on piles, concrete, and cast-iron are considered permanent in the present practice of the profession, and that I am fully justified in their adoption.

Alleged Danger to Foundations from an anticipated Scour of the Bed of the River.

I now turn to the words of the reporters—"We cannot but think it probable that the bottom of the river will not retain the peculiar form intended to be given to it. Should this be the case, the concrete banks around the piers must, in no long time, be broken up, and the piers be weakened; first, by the increase of their unsupported height, and secondly, by the diminution of the depth and solidity of the material through which the piles, of which they mainly consist, are driven."

This implies that the bed of the river is to be scoured away to some considerable depth below the line shown on my design. Now, in point of fact, the probabilities of a great scour will be diminished by the construction of the New Bridge, inasmuch as it will considerably enlarge the sectional area of the waterway.

As to the changes in the bed of the river, I have given the subject considerable attention, and in 1843 made soundings for her Majesty's Commissioners on Metropolis Improvements between Vauxhall Bridge and Blackwall, comparing them with the soundings of the river made by Mr. Giles for the late Mr. Telford in 1823 above London Bridge, and with the soundings made for the late Mr. Vaughan in 1799 below London Bridge.

Taking the average soundings in the Pool at 33 feet below Trinity datum, and the deep soundings at London Bridge at 30 feet below Trinity datum, the deepening of the river upwards at one foot per mile would give for the deepest soundings at Westminster Bridge 28 feet.

In the section of the bed under the arches of the new bridge, I provided for a depth by dredging of 30 feet below Trinity high-water line, which is a depth equal to that at London Bridge, and I arranged such a sectional area of waterway as would allow the stream to pass without any increased velocity at the bridge; so that, in reality, until the bed of the river were equalised between London Bridge and Westminster, there would be a *deposit* and *not a scour* at Westminster Bridge; but this equalisation of the bed of the river between Westminster and London Bridge would lay bare the platforms on which the piers of Waterloo Bridge rest.

The following statement of the sectional area of the waterway under the metropolitan bridges below Trinity high-water mark, will prove how imaginary is the idea of the scour on which so much stress has been laid.

	Superficial Feet.
Old Westminster Bridge	16,633
New Westminster Bridge	18,585
Hungerford Bridge	21,811
Waterloo Bridge	20,844
Blackfriars Bridge	16,447
Southwark Bridge	14,628
London Bridge	17,026

That the Committee may be convinced there is nothing to apprehend to the new bridge by the deepening of the river, I will mention two facts which I would prove by evidence, viz.—that the scour through the great arch of Old London Bridge having formed in the bed of the river (above and below that structure) a deep gulph, with 30 feet at low-water, this gulph was filled up, when the old bridge was removed, by the rubble stone and mortar from the old bridge, and any scour at that part would be effectually prevented.

Again, at Waterloo Bridge, where a regular series of soundings are taken every six months, there has been no change in the bed of the river during the last three years.

Being the engineer referred to on the part of the Crown during the last twelve years, to report upon all cases where applications have been made to the Corporation of London (and by them referred to the department of her Majesty's Land Revenue, under the Commissioner, the Honourable Charles Gore), for works on the bed and shore of the Thames, I may be allowed to speak with some confidence on this part of the subject; and having pointed out, in 1843, that a general lowering of the bed of the river would take place in the course of years, it is not probable that I should be unmindful of this circumstance in arranging the piers of the New Westminster Bridge; and I would state, with the fullest confidence, that the bed of the river round the piers of the bridge could not be disturbed by the changes in the river, nor would the piers be at all affected by that change.

But to place the matter beyond doubt, I have collated my memoranda on the tidal action of the river, and I find that, taking the mean level of the sea at Sheerness at 11 ft. 2½ in. below Trinity datum, a series of tidal observations for the month of February 1843, shows that the low-water at Sheerness was 18 ft. 2½ in. below Trinity datum, and the low-water at St. Katherine's Docks was 18 ft. 0¼ in. below Trinity datum,

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showing, as I told Mr. Rendel before the Committee, that the sea low-water level had already been attained in the Pool, where the tide ebbs at times 2 feet below the low-water level at Sheerness.

Again, the mean low-water at Sheerness, from three years' observations, is 18 ft. 5¾ in. below Trinity datum, and the low-water at Westminster Bridge for the month of May was 17 ft. 4½ in. below the same datum, only 12¾ in. above the mean low-water at Sheerness. Another proof of the fallacy and danger of putting forth opinions formed without a knowledge of the facts and circumstances of the case.

The Committee will observe that the assertions by Messrs. Rendel and Simpson are supported by *no proof*; that they make a general statement; "that judging from the effect of the river on the several bridges, they do not feel *that any plan which does not comprise solid stone piers and abutments carried down deep into the London clay, can be regarded as possessing a permanent character*," and they would thus stultify the works of those celebrated engineers, the Rennies and Brunel.

Now the fact is, that the only bridges affected are Westminster Bridge and Blackfriars; the former on account of its having no bearing-piles whatever (although Mr. Rendel stated in evidence that "it was repaired under the idea of its being a safe bridge, from the fact of its having bearing-piles"); and the latter, viz.—Blackfriars Bridge, having failed in consequence of its bearing-piles being *insufficient*.

But if a scour were to take place, and that to the very improbable extent suggested by the reporters, viz.—the whole stratum, about 6 to 8 feet thick of strong gravel which is above the London clay, and the concrete embankment outside the pier (which would be of the consistency of rock), were to be "broken up," what would be the consequence to the *pier itself*, supposing (which it is difficult to do even for argument sake) that this improbable movement could not be *easily arrested*?

There would remain within the iron casing of the pier the portion of gravel stratum originally enclosed on which the concrete rests. This gravel is incompressible and immoveable so long as it cannot escape sideways; and the same reasoning applies to the London clay, which constitutes the remaining portion of the materials enclosed.

As from the nature of the construction of the pier, there can be no opening in the casing to allow the passage of the gravel, it is impossible to conceive how the gravel could escape sideways. And as to the *diminution of the depth and solidity of the material through which the piles are driven*, this is surely an oversight of the reporters; for the piles on which the pier bears are *inside* the casing, and no alteration in the resistance there can take place till the casing be undermined by being washed under. Now, the foot of the casing is *deeper in the London clay than the solid masonry proposed in the report*. Thus again we have a conclusion arrived at without a reference to the facts.

I will here mention, in reference to the bed of gravel enclosed in the casing, so as to form a part of the pier, that the drawings of the foundations of Hungerford Bridge, coupled with Mr. Brunel's evidence, in 1844, of the nature of these foundations, explain it to be a bed of brickwork resting on the top of this very bed of gravel, the area being enclosed by a timber sheet piling. If, therefore, this gravel should be carried away outside, as the reporters anticipate, the Hungerford Bridge foundations will present only a timber defence. The Westminster Bridge foundations will present an iron one at the same relative level. Mr. Brunel's experience is surely a sufficient guarantee that nothing is to be apprehended as to the scouring away of this bed of gravel.

Although the reporters condemn the scheme as defective in many of its details, more especially in the construction of the piers below low-water, and recommend that the piers and abutments should be of solid stone carried down deep into the London clay, yet Mr. Rendel states, "If I could be quite certain that I could make this concrete which is put round the piles and is brought up to the level of the plinth course as unyielding as those piles, then I should say that was a firm foundation."

Now that he can be quite certain of this result is proved by his answers before the Committee on Westminster Bridge, June 1844, when, being questioned by Sir Charles Burrell as to the fact of the bed of gravel under the old caisson of the bridge being enclosed by the concrete and sheet piling so that it cannot move, he answers, "*Certainly it cannot move, and I do not think it would be possible to compress that bed of gravel.*"

Hence the gravel and concrete being incompressible, while the timber is slightly compressible, Mr. Rendel's conditions of a firm foundation are actually fulfilled.

Again, Mr. Rendel explains his ideas that the clay owes a portion of its ability to support weight to its *continuity*, which being cut off, there being no *bearing-piles* to carry the weight of the pier, the pier sank. And again, his ideas of a permanently-founded bridge are, "a bridge having its foundations carried so deep into the London clay as to ensure not only a strong foundation for it to stand upon, but a depth to which the river can never reach," or, *a bridge founded on piles in the ordinary way*. He illustrates this latter condition by reference to his bridge over the Lary, at Plymouth, which he says is a bridge standing upon a quicksand, *on piles*.

So far, therefore, as relates to the efficacy of the piles to support weight, and to the incompressibility of the gravel, Mr. Rendel's evidence of 1844 is conclusive.

The concrete being more unyielding than the piles, and the gravel being incompressible, the result is that any weight on the piles or concrete, or both, would be transferred to the clay. Mr. Rendel's reasons why the piles in my pier would not bear *equally* are based upon the absence of a timber grating or platform resting on and secured to the pile heads. Now, instead of this grating of timber, I substitute stone blocks or caps upon the pile heads, and upon these again are fixed the large granite plinth course 2 ft. 6 in. thick, which from its size and thickness effectually diffuses the pressure over the piles and concrete.

There is also this advantage in the granite platform over the timber platform, that the latter disposed sideways on the piles would be subject to actual compression, as may be seen in one of the caissons of the old Westminster Bridge, where the weight of the pier has caused an indent in the timber two inches in depth, and consequently must have produced a settlement of the pier to that extent.

In my arrangement all the timber is subject only to compression in the direction of its fibre, and it is loaded only with a weight which would not sensibly compress it in that direction, though it would in the other.

In both cases, whether the diffusing platform be timber, or granite, or concrete, the pressure comes upon the clay, and the foundations really terminate deep in the London clay, viz.—at a depth to the shoes of the piles of 48 feet below high-water Trinity datum, a depth of 10 ft. lower than that which is mentioned for the piers proposed by Messrs. Rendel and Simpson.

The opinion of Messrs. Rendel and Simpson upon the permanency of the piers is based in the assumption,—First, that the concrete footings round their bases constitute a necessary portion of the structure; next, that these concrete footings, forming part of the new bed of the river, will be broken and scoured away by the stream.

In reality the concrete footings will form no part of the structure. They are to be deposited at a depth below that to which the river can by possibility scour, and they are intended to guide the stream towards the centre of the arches under which the deepest water would, in the first instance, be provided by dredging, and afterwards maintained by the scour as thus directed; an engineering expedient so usual, that it may be called universal. The Committee have seen a sample of this concrete cut out of No. 4 Pier, four months after its formation, and may judge whether a stream of three and a half miles per hour would affect such a hard conglomerate, which Mr. Stephenson described as "the best concrete he had ever seen, and equal to the Portland stone of the old bridge."

This expedient has been described by Mr. Rendel as a dam across the river, whereas it only extends round the piers, and it completely excludes both air and water from the iron sheeting piles, and their junction with the granite facing above them.

Taking Mr. Rendel's answer to the question from Mr. Tite, "I doubt very much whether the stream would be able to deepen entirely down to the clay," it would appear that the precautionary footing of concrete is carried lower than Mr. Rendel himself deems necessary, seeing that it is carried down to the London clay.

On the Removal of the Old Bridge.

On the removal of the old bridge, the opinions of Mr. Rendel in 1844 differ widely from his opinions in 1856.

In 1844, being asked, "When you speak of the comparative expense of a new bridge and of reparing the old one, do you take into consideration the expense of removing the present piers, and the foundations of the present piers? Must not that be all done by coffer-dams."

Answer:—"*No; the old piers will be removed with very little difficulty.* I should say, *that the old piers would be removed with very great ease.* The drawing of all those piles which are driven round them would be a more formidable operation, but I apprehend not an operation attended with any heavy expense."

In the report of 1856, pp. 5 and 6, a new view of the subject is taken, thus: "This is a case *specially demanding the aid of coffer-dams for the better, cheaper, more expeditious, and safer removal of the arches and foundations of the old bridge.*" And again, in evidence (272), Mr. Rendel says, "You would not only with your coffer-dams have the means of building the new bridge in the manner there recommended, but you would also have the means of taking up the foundations of the old bridge, which I confess I look at as a matter attended with *some considerable degree of difficulty.*"

Again, in the report, p. 3, "We also think that there is great doubt as to the practicability of safely founding the new piers on the sites of the old ones without very considerable difficulty and expenditure in the removal of the old foundations and stone deposits."

Thus the evidence given by Mr. Rendel in 1844 to guide Parliament as to the erection of a new bridge in or near the site of the old bridge, and which, no doubt, influenced the decision of Committees and of the Commission, is diametrically opposed by his report and evidence in 1856.

"I am satisfied that the piers and caissons of the old bridge can be removed with very great ease, as stated by Mr. Rendel in 1844, and Messrs. Cochrane's offer to undertake the maintenance and removal of the bridge for 2500*l.* ought to be conclusive on this point. The effect of the weight of the old piers on the gravel and clay will be an advantage

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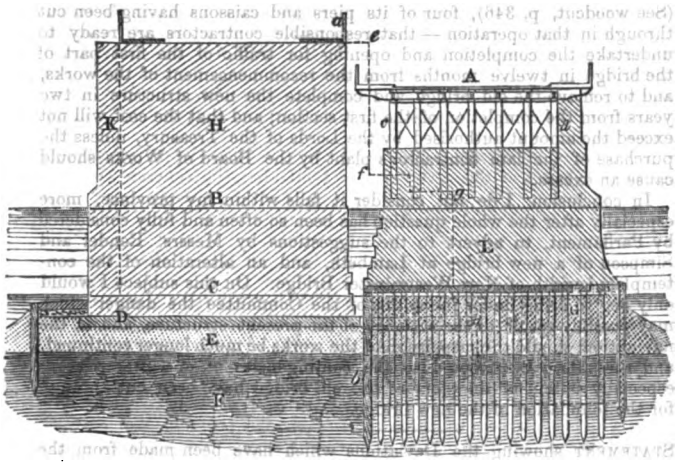
rather than a difficulty in forming the new foundations. I may here mention, that old London Bridge and its foundations were removed without the aid of coffer-dams.

Construction of the Bridge in independent Lateral Sections.

The reporters proceed to give an opinion on the expediency of building the piers in connected sections, alleging that it would be better to construct the whole of the bridge, except the road plates, in two detached portions, for fear of unequal settlement.

On this part of the construction of one part of the bridge before the other the Committee may require some detailed information; I therefore have shown on the accompanying engraving the position of one of the old piers, and of one of the new piers. The cutwater and caisson of the old pier on line *e*, *f*, *g*, *h*, are cut away to the line *a b*, and the iron and timber piling of the new pier is completed to the same line.

Position of one of the Old and one of the New Piers of Westminster Bridge.



A....Line of Roadway
B....Trinity Datum
C....Low water Line
D....Caisson of Old Pier
E....Gravel
F....London Clay
G....Concrete
H....Section of Old Pier
K....North Face of Old Bridge and of New Bridge
L....Part Section of New Pier

Width of Old Bridge, 44 feet. Width of first Portion of New Bridge, 48 feet.

The superstructure of the first part of the new bridge would occupy the space from *c* to *d*, leaving a footing or projection of the foundations of 5 ft. 2½ in. towards the old bridge. The Committee will observe, that the piles, &c. of the new foundations have been driven home close to the caisson of the old pier without any settlement in the latter, although it only rests on the gravel, without any other support. The statement that the driving of the piles in continuation of the foundations would disturb the piled foundation of the new bridge, which are deep in the clay, is too manifestly incorrect even to require contradiction.

Again, as the piles of the continuation will be submitted to a much greater force in driving than the superincumbent weight which they are to bear, no settlement, when that weight comes upon them, need be apprehended.

In the formation of foundations in detached lengths I had great experience in the worst ground at the Thames Tunnel, the foundations of which could only be proceeded with in lengths from 2 feet to 3 feet, and even when these foundations were put in, in the sand itself, the work was effected without settlement, by very simple expedients.

The practice of connecting together portions of tunnels, bridges, and other works built independently on every variety of foundations, sustaining immense weights, is so familiar that I cannot seriously entertain this objection in a case like the present, where every main point of support is *compelled to reach an identity of foundation*, viz.—the London clay.

Suggested Modifications of Plan.

In the evidence given by Mr. Stephenson and Mr. Hawkshaw, certain modifications in the detail of the foundation were suggested, which consisted in fixing the heads of the timber bearing-piles at a level below the lowest low-water line, and introducing a granite string-course below the granite plinth of the piers, to receive any blow from barges passing under the bridge at dead low-water.

Mr. Rendel would be satisfied that the foundation was firm if the concrete were as unyielding as the piles. This condition I have fully shown will be satisfactorily fulfilled.

Mr. Hawkshaw advised a projecting granite course to receive the blows of any vessels passing through the pier at dead low-water. As the navigation would be under or towards the middle of the arches, it is not probable that any vessels would navigate near the piers, and at ordinary low-water they could not strike the pile caps; but if precautionary measures are deemed necessary, there is no difficulty in arranging the masonry to afford protection against vessels.

All these suggestions are merely precautionary, and do not in the least affect the principle of construction.

Of the Temporary Bridge.

I come now to the opinion of the reporters that "the saving of the cost of a temporary bridge is not a sufficient compensation for the trouble, delay, risk, and extra cost consequent on the construction of a bridge in even two sections as now proposed, and the first in such close proximity to the old bridge."

On this subject, I beg to refer the Committee to Mr. Rendel's opinion before the Commission on Westminster Bridge in 1851. In answer to a question (343) from the Earl of Lonsdale, Mr. Rendel says *he would leave the old bridge until the new bridge was constructed*, and would save the cost of a *temporary bridge*, and also that he would (344) place the new bridge *immediately on one side of the old bridge*. In answer to a question (347) by Sir R. H. Inglis, he states "that the old bridge would perfectly answer the purposes of a temporary bridge while the new bridge was being constructed." In answer to Lord Seymour (349), whether "using the present bridge as a temporary bridge, and building the new one adjoining it, in order to make it of such a width as a bridge for the traffic ought to be, will it not cover part of the site which the present bridge now occupies?" Mr. Rendel states, "I have not gone minutely into that, but if it should be so, *I think no difficulty would present itself but what would be easily overcome.*" Again, in answer (353), he reiterates the importance *of saving the expense and delay of a temporary bridge*, and the removal of the present bridge before the new one is built. It thus appears from Mr. Rendel's conclusion—evidence given in 1851—that he was decidedly *against a temporary* bridge, and that he saw "no difficulty in constructing the new bridge immediately on one side of the old bridge;" also, "that if the width of the new bridge were to include part of the width of the old bridge," he *thought no difficulty would present itself which might not easily be overcome.*

By referring to my plans, it will be seen that what Mr. Rendel thought the best in 1851, I am now carrying out in 1856. I save the delay and expense of a temporary bridge; I use the old bridge until part of the new bridge, 33 feet wide, is built immediately adjoining the old bridge. I provide for including more than *part* of the width of the old bridge in the width of the new bridge (in doing which, Mr. Rendel thought no difficulty would present itself but what would easily be overcome). I avoid the use of coffer-dams and centres, and thus keep open the navigation. *I am, in fact, working out all the suggestions which Mr. Rendel approved of in* 1851, and *have overcome* the difficulties he anticipated would be overcome in doing so, and I now respectfully submit whether the opinions given by Mr. Rendel in 1851 should be set aside completely by his report of 1856.

Of the Superstructure.

The flat curves of the arches of the bridge, and their proximity to the roadway consequent upon the thin crown, rendered it desirable to provide for security and stiffness of the structure in such a manner as would avoid the use of cast iron in the central parts of the arches where they might be subject to percussions from moving loads. I therefore designed the arches with wrought-iron central ribs of ample strength and stiffness, whether taken as an arch or girder. In the centre arch these ribs are 52½ feet in length by 28 inches in depth; in the third and fifth arches, 50 ft. 8 in. in length by 26½ inches in depth; in the second and sixth arches, 45 ft. 6 in. in length by 24 inches in depth; and in the first and seventh, 42 ft. 3 in. in length by 22 inches in depth.

All the arched ribs are considerably stronger than is requisite for any load that can possibly be brought upon them, and they are made of this strength in order to secure great stiffness. And for this object I treated the wrought-iron rib as a fixed girder, taking the depth at the crown as a uniform depth for the girder, and under these conditions the breaking weight of the rib as a parallel girder would be 100 tons.

The deflection of the rib as a parallel girder fixed at the ends, and with a load of half a ton per foot distributed over its length, would not amount to more than ·15 of an inch with that load.

It will be evident, therefore, that the ribs, although so flat a curve, have a superabundance of stiffness, because in those calculations I have made no allowance for the increasing depth towards the ends, which amounts to 18 inches.

Some question has been made upon the provision for expansion in the iron part of the structure, and an impression conveyed that this has been neglected. Messrs. Rendel and Simpson inquired of me upon this subject, and were informed that the expansion in the longitudinal girders was provided for by vulcanised india-rubber in the joints. On this length of longitudinal girders from arch to arch, divided into three divisions, there would be an increase in length by a total change of temperature of 50° of ⅛-inch, or ½-inch at each joint.

There is no provision for expansion in the arches, which would rise and fall as in other iron bridges according to the change of temperature, in this case extending to half an inch each way; but Mr. Stephenson has

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made a suggestion which would allow this rise to take place more easily in the wrought-iron centre arched ribs.

It is a practice with some engineers to so fix the iron, that the force from the expansion is expended upon the iron itself, exerting a compressive force of one ton per square inch for every 15° of increase of temperature.

On this part of the subject the reporters state at page 6 of the report, that "they would make some additions to the thickness of the piers, and to the strength and stiffness of the iron superstructure." This conclusion is at variance with Mr. Simpson's evidence; for, in answer 289, he states, "that he has gone into the question of the strength of the bridge as regards the arches, and everything, and that he thinks there is ample strength."

Of the Width of the Bridge.

As to the width of the bridge, which the reporters recommend should be 60 feet, it is right to draw the attention of the committee to the width of the streets leading the streams of traffic to and from the bridge on both sides of the river. These are on the Middlesex side—

	Width of Carriage Way. ft.	in.	Aggregate width of Footpaths. ft.	in.	Total Width. ft.	in.
Bridge-street	32	0	16	3	48	3
Parliament-street	39	0	18	9	48	7
Great George-street	30	9	17	10	48	7
Abingdon-street	47	9	21	6	69	3
Victoria-street	40	0	22	6	62	6
And on the Lambeth side—						
Bridge-road	45	3	22	0	67	3
Pedlar's-Acre	21	0	10	3	31	3
Stangate	14	0	10	3	24	3
York-road	33	0	16	3	49	3

Now the width of the new bridge between the parapets is 83 feet, divided into two footpaths, each 15 feet in width, including the curb and two carriage ways, each 26 feet in width, with a curb in the centre, separating the going and coming traffic. These carriage-ways consist of two tramways for heavy traffic, seven feet in width, the remainder being paved granite road for ordinary traffic. For the convenience and enjoyment of the public, it cannot be considered that footpaths 15 feet in width are too wide, and considering the great and increasing traffic of the South-Western Railway, the increase of traffic from Pimlico in consequence of Birdcage-walk being open, and the traffic from Victoria-street and Parliament-street, few will, I believe, venture to assert that the carriage-ways are too wide. It may not be out of place to remark, that Mr. Rendel's decided opinion before the Westminster Bridge Committee in 1851 (answer 351 and 352) was, that the bridge should be not less than 70 feet in width.

Of the Approaches.

Messrs. Rendel and Simpson set down a sum of 384,000*l.* as involved in the cost of the bridge, supposing it to be built of a width of 85 feet. In this calculation, they have laid down the line of approach considerably wider than the new bridge, and not in accordance with its northern boundary. An inspection of the plan of the approaches will show that no property would be required on the north or lower side of the present line; and that on the south side, the houses in Bridge-street, Westminster, being required for the Houses of Parliament, would afford the space for widening that street to the width of the bridge. The only buildings to be removed for the approaches are seven houses between the bridge foot and Stangate, on the Surrey side, which may be estimated at 45,000*l.* Therefore, so far as the bridge approach is involved, the sum of 384,000*l.*, set forth in the report is really in excess to the extent of 339,000*l.*

	£
The estimate for a bridge 85 feet wide is stated by Messrs. Rendel and Simpson at	326,000
To which must be added the estimated cost of temporary bridge	35,000
To this must also be added the sacrifice of the work already done, and of part of the materials in stock, taken by them at	57,000
Making a total for the 85 feet bridge of	£418,000

(This sum is exclusive of the cost of blowing up and removing the present works, which may be taken at 10,000*l.*)

Then for the 60 feet bridge the estimate is	218,000
Cost of temporary bridge	35,000
Sacrifice of works and part of stock, as before	57,000
	£310,000

The time for completion being five years in each case.

In comparison with these estimates, I would observe that the estimate for the completion of the first part of the new bridge, 83 feet in width, is as follows:—

	£
For completion of foundations of piers and abutments to 3 feet above low water 7,854*l.*, of which there are materials on the ground amounting to 3,517*l.*; leaving to be provided	4,337
For the piers, abutments, and superstructure 51,013*l.*, of which there is 25,490*l.* of materials on the ground; leaving to be provided	25,676
Total for completing first part of Bridge in 12 months	£29,913
For the removal of the Old Bridge, and the completion of the new structure, 85 feet in width	121,285
	£151,170

Brought forward	£151,170
Amount already expended, as per Mr. Stephenson's valuation	55,053
	£206,223
Maintenance of Old Bridge	2,500
	£208,723
Add 5 per cent. on 151,090*l.* in consequence of delay.—(See Messrs. Cochrane's Letter, June 24, 1856)	7,558 10
	£216,281 10

General Conclusions.

I should state that the engineering arrangements for constructing the bridge have been most suitable to the circumstances under which the work had to be done, combining the maintenance of the old bridge for the traffic, and space for the navigation under its arches; that every operation hitherto has been perfectly successful, excepting in point of time, over which I had no control—that the foundations of the new bridge have been brought up close to the south face of the old bridge (See woodcut, p. 346), four of its piers and caissons having been cut through in that operation — that responsible contractors are ready to undertake the completion and opening for traffic of the first part of the bridge in twelve months from the recommencement of the works, and to remove the old bridge and complete the new structure in two years from the completion of the first section; and that the cost will not exceed the amount authorised by the Lords of the Treasury, unless the purchase of the late contractor's plant by the Board of Works should cause an excess.

In conclusion, I do not consider it falls within my province, more especially after the whole question has been so often and fully considered by Parliament, to advert to the suggestions by Messrs. Rendel and Simpson of a new bridge at Lambeth, and an alteration of the contemplated width of New Westminster Bridge. On this subject I would only beg to bring under the notice of the Committee the danger which may possibly result to the stability of the present structure, and to the navigation, should the suspension of the works be much longer continued, and the fabric be exposed to the contingencies of a winter season, especially as four of the piers of the old bridge have been cut through for the foundation of the new bridge.

STATEMENT showing the Deviations which have been made from the Contract Drawings, with their effect upon the Contract Amount, and the Dates when they were adopted.

1. An alteration in the design of the Surrey abutment, by which three culverts were introduced instead of the two arches. This alteration was suggested by Sir Charles Barry, to improve the architectural effect, assented to by me, and approved by Sir William Molesworth. It was determined on the 26th July 1854, and would reduce the contract amount by 3000*l.*

2. Driving the bearing-piles instead of screwing them, saving screw points to the amount of 1290*l.* This alteration took place in July 1854.

3. The substitution of a thorough course of granite at the base of the piers, 2 ft. 6 in. thick, in place of the iron curb, and the two layers of 9 inches Bradford landings. It was agreed with the contractor that this alteration should be made without affecting the contract amount. It was determined on July 1854.

4. Substituting for the three large cast-iron ribs the ordinary ribs of the bridge. This alteration was made in August 1854, and added 1 ft. 4 in. to the available width of the bridge, a quantity equal to one-sixtieth of the whole, and therefore gave an increased convenience to the public, while the change will cause a deduction of 1008*l.* With reference also to this alteration, I consider it desirable for the following reasons, viz.—that the great rib on the south side would have caused interference with the carriage traffic, when the first part of the bridge should be opened; and again, that a difference in the expansion of these ribs, and of the wrought-iron ribs in the centre of each arch, might have led to some irregular strains in the structure, and also that it would be desirable to construct all the arched ribs of the bridge on the same principle.

5. Substituting wrought iron buckled plates for the 4-inch oak planking for the flooring of the roadway. This alteration was made partly by reason of the difficulty experienced in procuring ship oak planking of the required size and quality, and was proposed to be made without any addition to the contract sum, provided part of the diagonal ribs and some of the wrought-iron bearers were omitted, which, by the adoption of the plates, could be dispensed with without detriment to the strength of the roadway. This alteration was determined on April 1855.

It is also intended to construct the interior of the piers of solid brickwork instead of filling the spaces shown by the contract drawings with concrete. This alteration would cause an addition to the contract sum of 696*l.* Arranged September 1854.

The balance of these deviations would be a sum of 4802*l.* in reduction of the contract amount.

The extra piling, dredging, &c., being dependent upon the ground, and not deviations from the specification, are not set forth in the list.

THOMAS PAGE.

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REGISTER OF NEW PATENTS.

MANUFACTURE OF BLOCKS OR SLABS FOR PAVING AND BUILDING PURPOSES.

EDWARD ROWCLIFFE, *Patentee*, December 22, 1855.

The object of this invention is the manufacture of blocks and slabs from natural asphalte. It has been the practice in making blocks of this material to melt the asphalte and run it into moulds; and asphalte has also been used for covering surfaces by using it in a molten state, and pouring it over the surface to be covered. The improvements consist in making blocks or slabs from asphalte without reducing it into a fluid state. Taking the natural asphalte, reducing it into small particles, then placing it in metallic or other moulds, and by hydraulic or other pressure giving it the form required. Sandstone or other materials may be pressed with the materials when necessary.

The asphalte to be used is first reduced to powder by slightly heating it. The powdered asphalte is placed in moulds made of wood or iron, according to the form and size of the slabs or blocks required, and then is subjected to great pressure, by hydraulic, or cam, or lever, or other powerful press, by which the asphalte will be formed into the moulded shapes desired, and they will be found to offer greater strength than when moulded by running melted asphalte into moulds. If desired, broken granite or other stone, gravel, or sand may be introduced into the moulds with the asphalte, or the bottom of the mould may have broken granite, or stones, or rough sand placed thereon, and the asphalte introduced therein, and the whole then subjected to pressure, either by forcing a cover (fitting the interior of the mould) from the upper surface downwards; or the upper part of the mould may be covered, and the bottom of the mould be caused to rise, so as to press the materials between the lower and upper parts of the mould; or the opposite sides of the mould may be made moveable, and the pressure applied at the side of the mould, according to the form of moulded articles desired to be made. In some cases, when making sheets, the asphalte may be placed between sheets of iron or other suitable material, and passed through between pressing rollers.

Claim.—The moulding of asphalte, with or withoutother materials, by the aid of pressure in moulds or moulding surfaces, as described.

MANUFACTURE OF MOULDED ARTICLES WHEN USING VITREOUS MATERIALS.

HENRY CHANCE, *Patentee*, January 29, 1856.

The invention consists in moulding articles from pulverised vitreous matter, such as cullet or waste glass, used either alone or mixed with sand or other substances, and afterwards heating the article so moulded to cause the vitreous matter to agglomerate into a compact mass.

Various kinds of pulverised vitreous matter may be used, but cullet or waste glass produced in the manufacture of ordinary window glass is preferred. The glass is first pulverised by being ground to the desired degree of fineness, and is used either alone or mixed with sand or other suitable material; the best proportion is three parts of ground glass to one of sand, but the proportion may be varied according to the size and nature of the articles to be made. The ground glass or mixture of glass and other materials is moistened with water sufficiently to enable the particles when compressed to hold together, and the mass is then pressed into a mould of wood, metal, or other suitable material of the required shape. The mould is to be so formed that it may be easily detached or delivered from the mass inside. When released from the mould the moulded article is carefully dried in a kiln at a low temperature. When all the moisture has been dried off or expelled, the article is immersed in and covered over with sand, to regulate the heat and to support any parts which might, if unsustained, give way during the burning. The kiln is then gradually brought up to such a temperature that the vitreous matter shall be partially fused or agglomerated into a compact mass.

MANUFACTURE OF CAST STEEL.

HENRY BESSEMER, *Patentee*, October 17, 1855.

(*With Engravings, Figs.* 1, 2, 3, *Plate* XXXII.)

To carry this invention into practical operation, a furnace is constructed having a long rectangular chamber, the mouth of which is on a level with the floor of the foundry; the sides and ends of the chamber are vertical and parallel to each other, and the bottom of it is formed into an elevated ridge, which extends the whole length of the chamber. This ridge is formed by the apex of a pointed arch, which is made below it, and is called the cave. Along each side of the furnace there are arranged fire-bars, which extend from the lower parts of the ridge for some distance up the vertical sides of the chamber, there being no fire-bars at the bottom of the chamber; the central part of the ridge is flattened, and there are formed in it at equal distances several holes, over or into which the lower end of the pots or pot-stands are placed, so as to insure the proper position of the pots. The top of the chamber is covered with large fire-tiles, or with an iron frame, in which fire-bricks are fixed, several openings being left to afford access to the pots. Along one side of the furnace there is a row of square holes leading into a chimney of sufficient height to insure a powerful draught. The pots preferred are of the form known as skittle-pots, with a lid to each, and a tapping hole made in the bottom of them. The pots should be placed on a stand some four or five inches in height, or the lower part of the pots may be elongated, so as to form a stand, and be of such a size as to fit the holes in the top of the ridge, so that access may be had to the under side of the pots from the cave below. The fuel used should be hard oven coke, which is supplied from the opening on the upper side of the furnace, the fuel filling up the spaces round about the pots, and rising as far as the top of them. The fire-bars are placed below the foundry floor, and the air for combustion is supplied from the cave below the furnace, which, when the draught of the chimney is alone depended on, must have a free communication with the outer air; but in order to obtain a powerful combustion in the furnace the cave below is closed up, and a blowing-fan is used, by which air is forced into the cave, to assist the draught of the furnace. In order to obtain access to the caves a revolving door is constructed, which is made to act as a valve, and will allow a workman to walk through it on one side of the axis (which is vertical), while at the other side a small portion only of the compressed air will make its escape, the revolving door being in part inclosed in a cylindrical casing.

This construction of furnace will be understood by reference to figs. 1, 2, and 3, Plate XXXII., in which fig. 1 represents a vertical cross section, taken on the line A B, of fig. 2; fig. 2 is a sectional plan, and fig. 3 a longitudinal section on the line C D, of fig. 2. *a*, *a*, are the outer walls of the furnace, which have openings in them at a^1, where the fire-bars *b*, are arranged so as to form a line with the vertical sides of the furnace. The fire-bars are divided lengthwise into three sets by the intermediate piers of brickwork a^2; these piers rest on or form part of the parallel walls *c*, *c*, which support the arch c^*; the upper side of this arch is flat along the central part of it, and has several circular holes *d*, made therein, into which the pot stands *e*, are placed on each side of the central flat part. The upper part of the arch c^*, is made to slope downwards, so that it forms an inclined solid bottom to the furnace. At a^3, there is formed an arch, which extends across the top of the furnace, and has openings *f*, made therein for the purpose of putting in the crucibles or pots, and for the supply of fuel from time to time. These openings are covered with a tile or stopper *g*, which may be moved aside when required. At *h*, there are other openings or flues, which terminate in a chimney *i*, part of which is shown as broken off. *j*, *j*, is the cave or chamber, in the centre part of which the furnace is erected. This chamber should be provided with an open passage to admit the external air freely when the draught of the chimney is alone depended on; but when it is intended to use a pressure of air to urge the furnace the communication with the external air should be closed up by means of a revolving door, which may be formed of thin iron or other suitable material, and which consists of four plates or leaves *k*, one side of each of them being inserted in a vertical axis *m*, and made to fit closely to the curved plates *l*, *l* so that as little air as possible may escape past them from the cave or chamber *j*. When the workmen require to go in or out they will pass into

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one of the recesses or segmental spaces between the plates *k*, and by pushing round the door may pass through without much loss of air. A blowing-fan or other blast apparatus, not shown, is made to force air into the cave *j*, and thus a most powerful combustion is maintained in the furnace, the air entering it at all the spaces between the fire-bars. It will be seen that the position of the fire-bars will prevent their becoming choked by the melted refuse matter of the fuel, which, instead of accumulating on them and becoming solidified by the entering air, will be received upon and flow down the inclined bed of the furnace, and escape beneath the bottom lines of the fire-bars.

Before commencing to use the furnace it will be necessary to gradually bring up the pots to a red heat in a suitable oven, and also to make a small fire inside the furnace, and bring it up to about the same temperature as the pots, which are then to be quickly placed therein and the fire increased. An iron support is then passed upwards against the under side of each pot, which should have a hole from 1 to 2 inches in diameter made in the bottom of it, and against the under side of which holes the iron supports rest. The workmen will then throw into the pots a small handful of coarse dry sand, which will fill up the hole in the bottom, and prevent the pot from leaking, or in lieu of this a spherical ball of burned fire clay may be put into each pot, the ball being too large to fall through the hole below. A little broken glass is then thrown into the pot, which will lute up the joint and retain the metal. On the floor of the cave beneath the pots is fixed a line of rails, on which an iron carriage can be moved. This carriage contains the moulds into which the molten steel is to be run, the moulds being so arranged as each to receive a charge of metal from the pots. When the iron supports are removed a rod is introduced from above to displace the ball or the stopping of sand, which will have become concreted into a mass, but sufficiently friable to be easily removed. When a casting has taken place the moulds are wheeled away with their contents, but may be again wheeled under the furnace when required; sometimes, however, the contents of all the pots may be required for one casting, in which case a gutter lined with loam is extended below the line of pots, which receives their several contents, and conducts them into the mould in like manner. The contents of two or more furnaces may be conveyed into one mould, the furnaces being so arranged as to come as near as convenient to each other, and whereby any massive castings may be produced by the combined charges of steel from the several pots contained in the different furnaces. In fig. 1 the ingot mould *a*, as shown in section, is placed within its carriage *p*; the two halves of the mould being held together by wedges *r*, driven in between it and the sides of the carriage. In fig. 3 the carriage is shown with two moulds only in it; they occupy their proper place for receiving the contents of the pots or crucibles *s**. The supporting rods *t*, are represented as still in the position they occupy previous to their removal for the discharge of the metal; they rest on the central part of the horizontal bar *u*, the ends of which are supported by projections *v*, formed on the walls *c*, *c*, the elasticity of the bars *u*, serving to keep the upper enlarged ends of the rods *t*, firmly pressed against the bottom of the pots.

For the conversion of crude or refined pig iron into steel, the patentee constructs a finery furnace at a convenient distance from the furnace before referred to, or a common cupola blast furnace, in either of which the pig iron intended for conversion into steel is melted. From time to time the finery or cupola furnace is tapped, and the molten iron run into a ladle; the metal is poured from thence into the pots before described, where its high temperature will be still further increased. Above the furnace an iron pipe is fixed, covered with brickwork, or otherwise protected by a bad conductor of heat. Into this pipe highly heated atmospheric air alone, or air and steam mixed, or steam alone, also highly heated, is forced under a pressure exceeding that of a column of metal equal to the depth of fluid metal in the pots. Although the action of highly heated air or steam produces a more rapid change in the quality of the metal than cold air or steam of low pressure, and for that reason is to be preferred for the purposes of the invention; it will, nevertheless, be understood that air less heated, or of the ordinary temperature of the atmosphere and steam of the temperature due to a low pressure, may be used in all cases where it is desired to do so. The flow of air or steam into the pipe A, is to be regulated by a valve under the control of the workmen who attend the furnace. A small moveable pipe is placed vertically over the centre of each pot, and passes freely through a hole into a branch of the air pipe above, and is capable of sliding downward as far as the bottom of the pot, or nearly so. In order that the pipes when they are withdrawn from the pots may be moved on one side, and thus afford free access to the furnace mouth, they are made in the following manner:—The main steam or air pipe A, is placed horizontally over the furnace, and is kept in position by rods or stays attached to the roof or other part of the building. This pipe has fitted to it several jointed branches B, so made that the upper part of the pipe B, embraces the lower half of the pipe A, and is provided with lugs, by means of which a curved clip C, is fastened to it, and made to embrace the upper side of the main pipe, so that the pipe B, which is pendant, may be moved backwards and forwards when desired, as represented at B*, fig. 1. The under side of the main pipe has holes made at the parts where the pipes B, are fitted to it, so that the air or steam may have free access to the pipes B, the lower parts of which are bored out and fitted accurately to the sliding piece of pipe D, at the upper end of which there is an enlargement or collar to prevent it from falling out of the pipe B. It is also provided with a socket E, at its lower end, which is fitted on to a short length of stout pipe G, made of malleable iron, platina, or other metal, which descends nearly to the bottom of the pots, but if prevented from quite reaching the bottom in consequence of the raised collar or projection formed at the upper end of them, and by which they are supported on the top of the covers H, of the pots *s*, during the time they are immersed in the metal, from which they should be withdrawn from time to time in order that they may be cooled down. This movement into or out of the metal under operation is also of great importance, as it allows the apertures from which the jets of air or steam issue into the molten metal to be lifted above the surface of it, or be entirely removed, and thus the tendency which such apertures have to become clogged up is in a great measure avoided. The lower ends of the pipes G, may have a single orifice made therein, or there may be several smaller holes, as it divides more completely the air or steam into small portions. The apparatus being thus arranged, the operation will be as follows:—The pots having been charged with molten iron in the manner described, the workmen will lower the small vertical pipe D, on to the pipe G, which passes through a small hole in the cover, down nearly to the bottom of the fluid metal, through which the air or steam will force its way to the surface, producing considerable agitation of the melted metal, and thus in turn exposing every part of it to the chemical action of the gaseous products passing through it, the oxygen of the air or decomposed steam absorbing rapidly the carbon of the iron, and carrying it off, as also the sulphur or other volatile matters. As soon as the iron becomes somewhat pasty (as it is liable to do when steam is being used and the heat is not fully maintained), or exhibits other signs of sufficient decarbonisation, as herein explained, the pipes are lifted up and some additional heat given to the metal (which may now be considered steel), in order to render it sufficiently fluid to run into moulds. During this last heating the pot lids must be put on to prevent too great a loss of carbon. By reference to the several figures, it will be seen that the crucibles *s*, are provided with covers H, in which several holes N, are made, and by means of which the gaseous products arising from the combustion of the carbon of the iron and other volatile matters are allowed to escape into the furnace. Although the steel may be retained in the furnace, as before described, for the purpose of being further heated after the process of forcing air or steam therein has ceased, it will, nevertheless, be found that by proper attention to the furnace fire the workmen will be enabled to maintain the metal in such a state of fluidity through the decarbonising process when using steam as to avoid the necessity of applying any further heat thereto, and whereby the fluid steel so produced from crude or refined iron may be at once formed into any desired article by the process of casting in iron moulds, or founding the same in loam or sand moulds, such as are commonly used by ironfounders; or the fluid steel may be run into ingot moulds for the purpose of forming ingots or masses of malleable cast steel suitable for being tilted, hammered, or rolled into bars, plates, or rods by the processes already known and practised for that purpose. During the decarbonising process, the state of the metal may be tested by dipping out a sample with a small ladle, as practised in refining copper; if too much carbon is retained, the pipe G, may be again introduced for a short time, or a small quantity of scrap iron may be put into it; but if too much carbon has been driven off, an addition may be made of some melted iron from the finery or cupola furnace; a little experience will, how-

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ever, enable the workman to regulate his process so as to produce the different qualities of steel which he may require, for which purpose he must note the time that a given weight of iron requires with an ascertained pressure of air or steam to produce steel of a certain standard of hardness; he will then apply the air or steam for a less length of time if he require a harder steel than the standard, or he will continue the process for a longer period if steel of a very soft or mild quality is required. In all cases, however, the process must be continued until the metal is rendered ductile and malleable, and acquires other properties common to cast steel.

Although it has been shown how the pot may be supplied with melted metal from a finery or cupola furnace erected for that purpose, it will be obvious that molten metal may be run direct from the blast furnace in which it has been obtained from the ore, the choice of which modes of operating will depend much on local circumstances and on the quality of steel required. In order that the nature and extent of the invention may be correctly ascertained, and in what manner the same differs from some other methods that have been heretofore used or proposed to be used for making iron and steel. The patentee states in the first place that he does not use either the puddling furnace or the manipulation called puddling, nor is the iron solidified or made into balls, or removed from the vessels in which it is treated for the purpose of remelting the same, but is retained therein in a fluid state until the completion of the process, and is allowed to flow from thence into suitable moulds. In the second place, he says that both air and steam have before been employed in the manufacture of iron in different ways, and it has recently been proposed to dispense with the finery or running out furnace in the manufacture of iron by causing jets of air or steam or water to pass up through the melted crude iron as it flows along a gutter from the blast furnace, or after it has run into the pig beds, or after it leaves a finery furnace (if one should be used), but in either case it is proposed to use such process only as a preparatory process to puddling in a reverberatory or puddling furnace in the ordinary manner; and thirdly, that the blowing or forcing of steam into and below the surface of fluid iron contained in a reverberatory or puddling furnace has before been proposed, and may have been practised, such introduction of steam forming part of and assisting in the process of puddling iron, in which case the fluidity of the metal would not, as in the process of manufacture herein described, be maintained throughout the process.

These different known processes are mentioned to show that no claim is made thereto, and also to show more clearly the distinctive character of the invention, which consists in the production of malleable metal direct from crude or refined iron by means of air or steam, or both, whilst retaining it in the fluid state, and without the use of the puddling furnace, or of any manipulation or process analagous to the puddling process, at the same time admitting of the fluid metal after the completion of the process being run or poured into moulds, or formed into ingots suitable for the further process of hammering or rolling.

Although a peculiar construction of furnace has been described in which pots are used, and wherein the pots are so arranged as to discharge their contents through the bottoms for successful and economic working, yet the main or primary object of this invention may be successfully accomplished in the furnaces and crucibles at present in use for manufacturing cast steel, and also by many other modifications and forms of apparatus, provided that such apparatus is so arranged that currents of air or steam, or a mixture of air and steam, may be forced into and among the particles of fluid metal until the separation of so much of its carbon and other impurities has been effected as will render the metal so treated malleable and ductile whilst it still retains a fluid state, and, like cast-steel produced by other means of manufacture, capable of being run into moulds to form ingots or other articles of cast-steel.

The workman may always judge, more or less accurately, of the state of the metal as the process proceeds, by observing the colour and size of the sparks, and the quantity and colour of the flame issuing from the metal under operation.

The tendency of the metal to become less fluid towards the close of the process, although it may indicate the lessened quantity of carbon in the metal, may also be caused by the use of too much steam, or from a cooling down of the metal, consequent on the withdrawal of the blow pipe for too long a period of time, or it may arise from other causes, and, therefore, taken alone, should not be relied on as an indication of the state of the metal, more especially as such a condition of the metal should and may be entirely avoided. The use of steam has always a tendency to cool down and lessen the fluidity of the metal when used alone towards the close of the process. The patentee has therefore found, in carrying his invention into practical operation, that it is preferable to use steam at the early stages of the process, and to use air for its completion. It is also found that the employment of steam is very serviceable when the crude iron contains sulphur, because the steam becomes decomposed on passing into the fluid metal and yields hydrogen gas, which readily combines with the sulphur and carries it off; but steam is not so well adapted as atmospheric air to maintain the necessary heat and fluidity of the metal. Preference is given to the use of steam only in the early stage of the process, when the iron contains a comparatively large quantity of carbon, and is consequently easily maintained in a fluid state, notwithstanding the cooling effect of the steam, which is generally employed for about one-third of the time that is required to bring the metal to the proper quality. No precise rule can be laid down as to the time required by the process, which must in every case depend both on the quality of metal used, and on the quantity of steam or air passed through it, but it may be stated generally that from twenty to forty minutes will be required. The steam having been used as long as the workman considers necessary, he will shut the steam passage and open a communication with the blast pipe, and allow the air to force its way into the metal. The change will soon become apparent; the metal, which may have lost much of its heat during the steaming process, will quickly brighten up, an increase of flame will be observed, and a rapid increase in the temperature of the metal will take place, it passing from a red or yellow heat to an intense white; a violent ebullition of the metal will also be observed during any intervals in the blowing operation, in consequence of the disengagement of gaseous carbon or other volatile matters in the act of separating from the metal; a similar effect will be obtained by using a small quantity of steam mixed with the air throughout the process, but it is best to use them separately, as before stated; and the workman should take care that the hole in the top of the furnace, and in the cover of the pot through which the blowing pipe passes, should be sufficiently large to allow him to see through it what is going on.

Claim.—The forcing of currents of air or of steam, or of air and steam, into and among the particles of molten crude iron, or of remelted pig or refined iron, until the metal so treated is thereby rendered malleable, and has acquired other properties common to cast steel, and still retaining the fluid state of such metal, and pouring or running the same into suitable moulds.

MANUFACTURE OF MALLEABLE IRON AND STEEL.

HENRY BESSEMER, *Patentee*, February 12, 1856.

(*With Engravings, Figs.* 4, 5, 6, 7, 8, *Plate* XXXII.)

The invention consists in the decarbonisation or partial decarbonisation and refinement of the crude iron which is obtained in a fluid state from the blast furnaces in which the iron ore is usually smelted, or the decarbonisation and refinement of crude pig-iron or finery iron by first remelting the pigs of crude iron or the plates of finery iron in any suitable furnace, so as to obtain fluid metal for the purpose of being treated by the improved means, and which consists, firstly, in running the fluid iron into a close or nearly close vessel or chamber, formed by preference of iron, and lined with fire-bricks or other slow conductor of heat. When the chamber or vessel is about half filled numerous small jets of atmospheric air are blown or forced into and among the fluid metal in a cold or in a previously heated state, or any other gaseous fluid or matter containing or capable of evolving sufficient oxygen is used to cause the combustion of the carbon contained in the iron, and thereby to keep up the required temperature during the process. The size or number of the jets or tuyere pipes by which the air or other gaseous matters are conducted into the molten metal should be proportioned to the quantity of fluid metal operated upon at a time, and may also vary with the condition or quality of the metal; thus, forge, pig, or refined plate metal, will not require so much oxygen to complete its decarbonisation and conversion into steel or malleable iron as is required for the conversion of crude iron of the qualities known as No. 1 or No. 2 foundry iron, to which last-named

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BESSEMER'S PATENTS FOR THE MANUFACTURE OF MALLEABLE IRON AND STEEL.

Fig. 4.

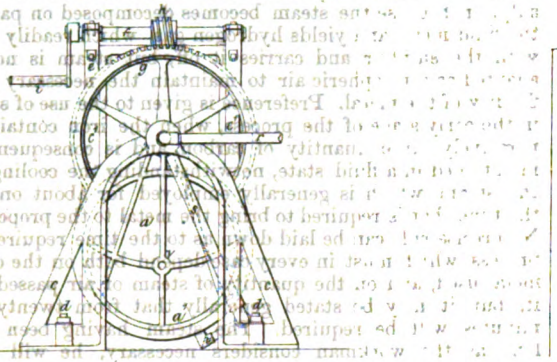

Fig. 1.

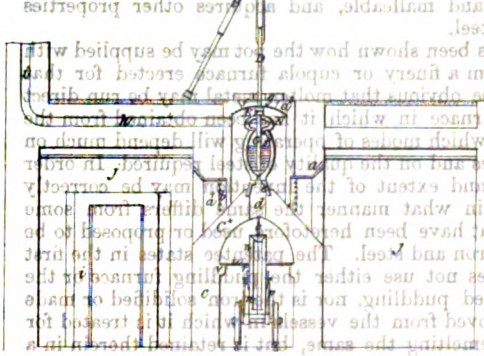

Fig. 5

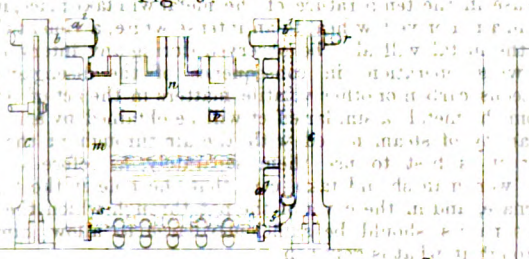

Fig. 2.

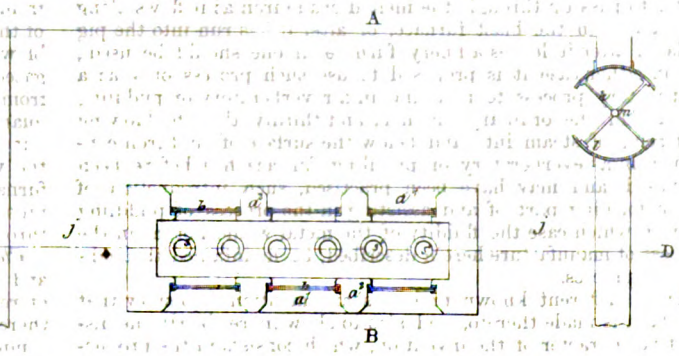

Fig. 6

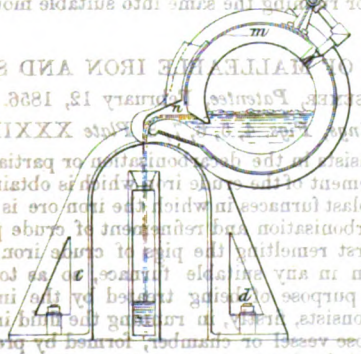

Fig. 3.

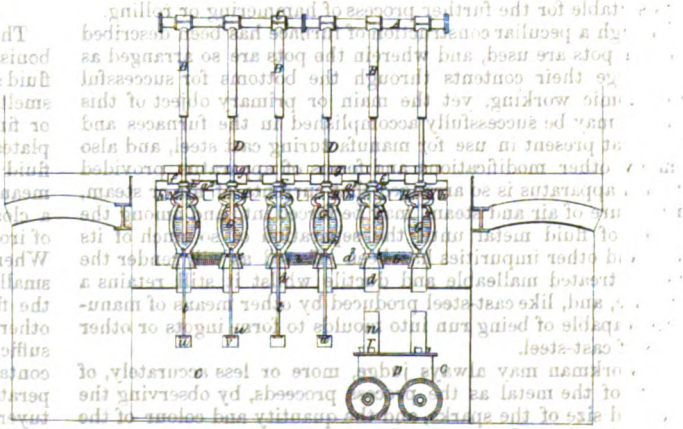

Fig. 7

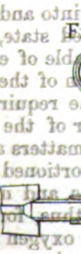

Fig. 8

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J. R. Jobbins

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qualities of iron the patentee prefers to use tuyeres having an outlet of about 20 per cent. more in area than those which are used for the white qualities of iron. It is, however, difficult to give a precise or fixed rule for the size of the jets or tuyere pipes, because the quantity of air passing through them depends so much on the force or pressure of the blast; the quantity should depend also on the quality of the iron, and the heat of the air or other gaseous matters used with the air or in lieu thereof; but as a guide to the workman, the patentee gives an example, which he has found in practice to answer well:—When using foundry iron of the quality known as No. 2, he runs one ton of it into the converting vessel, in which it rises to a height of about one foot above the orifices of the tuyere pipes; he then forces into the fluid metal atmospheric air in its natural or unheated state, under a pressure of about 10 lb. per square inch, and he employs from six to twelve tuyere pipes for the distribution of the air, the united area of the tuyeres being equal to two square inches. The quantity of blast admitted by this area of inlet will in general be found sufficient to effect the conversion of the crude iron into a malleable condition in about thirty minutes; but should it be preferred to use a mixture of oxygen gas with atmospheric air or steam, or to use steam alone, or any other gaseous fluid capable of evolving oxygen in lieu of atmospheric air, then the size of the tuyere pipes should be regulated according to the quantity of oxygen contained in such gaseous fluids, any excess of oxygen over that usually contained in atmospheric air will admit of a diminution of the tuyere pipes, while a deficiency of oxygen will render necessary a corresponding increase in the size of the tuyeres. The interior of the vessel may in some cases be heated by the waste gases of the blast furnace, or by any other convenient means, previous to the crude iron being poured or run therein. But this heating up of the vessel will only be necessary at such times as the vessel is used with a new lining, which should be well dried, or at such other times as the vessel may be used after the process has for several hours been discontinued, in which case he prefers to reheat the vessel, although the process may be conducted successfully in a vessel that is perfectly cold previous to the running in of the molten iron.

Now, it is well known that molten crude iron under ordinary circumstances will soon become solidified, unless a powerful fire is kept up, and is applied direct to the fluid metal, or to the exterior of the vessel containing it. It is also well known that if the quantity of carbon which is usually associated with crude iron is diminished, that the temperature necessary to maintain its fluidity also rises in like manner, so that when the iron has lost the whole or the greater part of its combined carbon that such metal can only be kept in a fluid state by the heat of the most powerful furnaces. But the patentee has discovered that if atmospheric air or oxygen is thus introduced into the metal in sufficient quantities it will produce a vivid combustion among the particles of fluid metal, and retain or increase its temperature to such a degree that the metal will continue fluid during its transition from the state of crude iron to that of cast-steel or malleable iron without the application of any fuel;" the requisite high temperature of the metal by such mode of action being obtained by the oxygen uniting with and causing a combustion of the carbon contained in the crude iron, and also by the combustion of a small portion of the iron itself.

In carrying this invention into practical operation the patentee prefers to mount the refining vessel or chamber on axes not situated at or near the centre of gravity of the said chamber, by which means the pouring out of its contents will be facilitated, and the spout kept in a proper position in reference to the mould during the time of pouring the fluid metal therein. The air may be introduced at the sides or ends of the vessel through small holes formed in pieces of well-burned fire-clay, so that by moving the chamber or vessel on its axes the holes in the fire-clay may be made to descend beneath the surface of the metal, or be raised above it as desired. It must be observed, that the air or other gaseous matters must be compressed with a force greater than will balance the weight of a column of fluid metal of a height equal to the depth of immersion of the jets below the surface of the fluid metal.

In order that this particular form of apparatus may be fully understood, we have annexed an Engraving, in which the same is represented; fig. 4 being an end elevation thereof; fig. 5 a longitudinal section of the vessel or chamber; and fig. 6 a cross section of the same. The tuyere pipes are also shown in detail on a larger scale at figs. 7 and 8.

The cylindrical vessel *a* is formed of stout plate iron, secured by angle iron flanges to the cast-iron end plates a^1, on which ribs or webs are formed for the purpose of giving to them the requisite degree of strength. At one side of the plates a^1, and at a point beyond their outer edges, the bosses a^2 are formed; they are bored out truly, and fitted and keyed to the axes *b* and b^1, on which the converting vessel *a* is made to move when required. *c*, *c*, are iron frames secured by bolts *d* to the masonry or foundation, on which the whole apparatus rests. The frame c^1 rises higher than the others, and has plummer blocks *e*, *e*, bolted to it, in which the shaft *f* revolves. A worm wheel *g* is keyed firmly on to the axis *b*, and receives motion from the worm *h* whenever the handle *i* and shaft *f* are moved round. The interior of the vessel *a* is lined with fire-bricks or fire-stone, as shown at *m*, or it may be lined with any other slow conductor of heat capable of withstanding the high temperature and solvent action of the slags to which the lining is exposed when the vessel is in use. The bricks or fire-stone, may, however, be protected and mended or patched from time to time by a coating of loam, road drift, iron ore, slags, or such other matters as are commonly employed for mending and protecting the walls of furnaces used in the manufacture of iron. The lining may be renewed from time to time when worn out, by removing either of the end plates a^1, which may again be bolted on to the vessel as soon as the new lining is completed, or a man-hole may be made in one side of the vessel, through which the lining or repairs may be effected without removing the end of the vessel. At *n* there is formed a projecting spout or lip for the purpose of running out the fluid metal. This lip is made to project from the vessel so far as to bring it in a line with the axis, so that into whatever position the vessel *a* may be moved the extremity of the lip *n* may retain the same position or nearly so, and thus allow the stream of metal flowing over it to fall into the ingot mould, which would not be the case if the axis were placed in a line with the centre of the cylindrical vessel. By reference to fig. 6 it will be seen that at m^1 the lining is formed so as to prevent the metal from carrying out with it the slags or other matters floating on its surface, until after the metal has run out. On each side of the spout *n* there is a curved passage *p*, by means of which the flame and gaseous products evolved during the process may escape, but the splashes of metal thrown up by the jets of air are for the most part prevented from escaping from the vessel by the serpentine form of these outlets. At *r* there is a pipe, which is made to communicate with a blast engine or with a steam-boiler, or it may be made to communicate with a reservoir containing oxygen gas, or a mixture of oxygen with other gaseous fluids, or with any gaseous matter capable of evolving oxygen, any or all of which gaseous fluids may be used for the purpose of this invention either in a cold or heated state, although the patentee prefers to use atmospheric air at its natural temperature on account of its cheapness and efficiency. The pipe *r* is fitted at one end to the trunnion or axis b^1, which is made hollow, and is provided with a stuffing-box or other joint, so as to allow the movement of the axis without interfering with the passage of the air or other matters through it. The pipe *s* is also connected with the hollow axis b^1, and has a right-angled elbow or bend at its opposite end, and then continues along the outside of the vessel throughout its whole length; that portion of the pipe is marked s^*, and is turned truly on its exterior surface, and has fitted upon it several small branch pipes *u*, each of which has a T piece connected to them, which is bored out truly, and made to fit accurately to the exterior of the pipe s^*, so as to admit of the pipe *u* being moved on the pipe s^*. Along one side of the converting vessel there is a row of square holes, into which small blocks of well-burned fire-clay are loosely fitted; they are held in position by ramming a little loam well into the joint formed between them and the lining *m*. At one end of these blocks or tuyeres the pipe *u* is fitted by a simple cone joint; the other ends of the tuyere blocks have several small holes made in them leading into one larger passage, which communicates with the pipe *u*, so that a communication is thus established between numerous points of the interior surface of the converting vessel and the blast engine or reservoir of gaseous matters, before referred to, and by means of which numerous small jets or currents of air, or other gaseous fluids, may be forced into the converting vessel when required, a sluice cock on the pipe *r* (not shown in the engraving) enabling the workmen to turn off the supply of air when required.

In order that the way in which the pipe s^*, and the pipes *u*, are arranged may be better understood, we have shown a detached

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view of them at fig. 7, where it will be seen that the pipe s^*, has a hole in it at x, which is opposite the orifice of the pipe u; through this hole the air may pass freely when the pipes u, occupy their ordinary position, but whenever any of the tuyere blocks require renewing, the pipe u, can be turned up on the joint formed at its union with the pipe s^*. Fig. 8 shows a longitudinal section of a tuyere block, where z, z, show the small apertures through which the air escapes into the metal, all of which passages unite in the larger one z^*, the orifice of which is made conical, so as to fit the end of the pipes u. It has also been found that a single outlet in each tuyere block will answer well in practice; in this case a single parallel passage y, leads direct from the pipe u into the metal; as these passages sometimes get obstructed, a screw plug q, is fitted at the back of the elbow of the pipe u, which plug may be removed, if required, while the apparatus is in use, and a steel rod introduced at the aperture, which should be thrust entirely through the tuyere block, and any accidental accumulation of matter will be thus removed. By reference to fig. 4 of the Engraving, it will be seen that a boss v, is formed at the point of junction of two of the webs, which are formed on the end plates a^1, of the converting vessel; into this boss a stud is fixed, to which a chain or tension rod may be attached, for the purpose of suspending a counter-balance weight, the chain passing over a pulley supported by the roof or other convenient part of the building, so that the vessel a, may be more easily moved on its axis by means of the worm wheel gearing, before described.

Having thus pointed out the manner in which the converting vessel and the apparatus connected therewith is constructed, we will proceed to describe in what manner the conversion of molten crude or finery iron is to be effected therein. The patentee, however, wishes it to be distinctly understood, that although he prefers to use the above apparatus for the purpose of carrying out his invention, other forms or modifications of the converting vessel may be used, with more or less advantage; and that the same may either be made moveable or it may be fixed. The apparatus should, by preference, be placed near to the discharge hole of the blast or re-melting furnace from which the crude fluid iron is obtained. The interior of the converting vessel may be heated by burning gases therein, in a manner well understood, or some wood, charcoal, or coke may be introduced at the passages p, and a blast of air turned on through the tuyeres, by which the combustion of these substances may be kept up. When the fuel is consumed, and the vessel dried, the air or other gaseous matters may still continue to be forced in during the time that the crude iron is running from the smelting furnace into the vessel; for this purpose the vessel is put in the position shown in fig. 6, a moveable gutter leading from the tap-hole of the smelting furnace into the upper end of one of the passages p. The charge of metal will vary according to the size of the apparatus, but the patentee prefers, as a general rule, that the vessel should be a little less than half filled with metal. As soon as the metal begins to accumulate above the orifices of the tuyere blocks a violent ebullition will be produced, the air dividing into globules and diffusing itself among the particles of fluid iron, and thus coming in contact, at numerous points, with the carbon contained in the crude iron, and producing thereby a vivid combustion, while the flame and gaseous products resulting therefrom make their escape by the passages p. If the crude iron is run into the vessel at a low heat, or only a little above its fusing temperature, it will be found rapidly to increase in temperature, and at the expiration of about fifteen minutes from the time of commencing the process, large frothy slags will begin to be thrown violently out of the passages p, accompanied by a rush of bright flame; after a few minutes' duration, this eruption of slags entirely ceases, but a copious flame still continues to escape by the passages p; the crude metal, at this stage of the process, has thrown off the bulk of its impurities, and in a few minutes more is in the condition of cast steel; the exact state of the metal may, however, be ascertained by turning the handle and shaft f, so as to bring the vessel on its axis into the position shown in fig. 6, and thereby discharge a small quantity of metal into an ingot mould, which should be quickly cooled and examined, and if found to be not sufficiently decarbonised, the handle should be reversed, the vessel lowered, and the process be continued until the metal is decarbonised and purified to the desired extent. From five to ten minutes additional blowing is generally found sufficient to bring the metal from the condition of cast-steel to soft malleable iron. Whenever it is desired to suspend the operation of blowing for a short period, the vessel should be raised into such a position that the upper surface of metal is below the orifices of the tuyeres, so that the forcing in of the air may cease without the tuyeres becoming stopped up with fluid metal, which would be the case immediately the blast of air is stopped, provided the orifices of the tuyere blocks were not raised above the surface of the metal in the manner described. In making malleable iron from crude pig-iron of No. 1 or 2 quality, about thirty to thirty-five minutes is required for the whole process, but the exact point to stop the process so as to obtain metal of any degree of hardness between hard steel and soft malleable iron, will soon be acquired in practice by the workman, since the colour and volume of flame issuing from the passages p, varies with the condition of the metal, and forms a good guide for the workman to judge by; he can also take a trial ingot, in the manner described, at any stage of the process if necessary. It is found that such an excess of heat is produced in the process that the metal continues to boil even after the blast of air has ceased, and although reduced to the condition of malleable iron, is still so far above the melting point of that metal that it is desirable to lower its temperature before casting or pouring it into moulds; for this purpose the vessel is brought into such a position that the upper surface of the metal is below the orifices of the tuyeres; the supply of air is then stopped, a fire tile placed over the orifice of the passages p, so as to prevent the heat from escaping too rapidly, and thus cooling and solidifying the surface of the metal. In this way the metal may subside, and be gradually lowered in temperature, and be brought into a proper condition for pouring or casting; or in place thereof it may be allowed to cool down, and be stirred or worked, and taken out of the vessel in masses.

The patentee mentions in his specification that he is aware that it has before been proposed to subject crude melted iron to the action of streams of air or steam when flowing in a trough from a blast furnace or from a refinery furnace, also when in pig beds, and it has been further proposed to apply streams of air and steam when puddling iron heated and kept heated in a puddling furnace; but in all cases, heretofore, the rendering of crude melted iron into malleable iron or steel, the iron has required to be heated in a suitable furnace by the continued combustion of fuel, whereas in the process above described the heat contained in the crude melted iron is increased, and rendered sufficient for obtaining or producing the conversion of the iron into steel or malleable iron, by the simple application of streams of oxygen applied to such a mass of melted iron; and he mentions these facts in order the more fully to ascertain and define the peculiarity of his invention, which he declares to consist in acting on a mass of melted crude or cast iron when in a suitable vessel by streams of oxygen (contained in atmospheric air or otherwise) and without the further consumption of fuel, for heating the vessel or the iron to convert such fluid, crude, or cast iron into steel or malleable iron. During the interval occupied in cooling down the boiling metal, the workman should get his ingot moulds, when they are to be used, in a position to receive the still fluid metal; a convenient way of doing this is to place them in an iron truck mounted on wheels, which may be moved under the spout of the vessel, and pass out under the arched openings left in the frames c, c, for that purpose.

As soon as the casting of the ingot is completed the moulds should be removed and the vessel again lowered down into the position shown in fig. 5, when the blast of air may be again turned on to the pipes u, and s, and another charge of crude iron be run into the vessel to be treated in like manner.

The process of decarbonisation and refinement of the metal may thus be carried on until the metal is reduced to the condition of hard or soft steel, or to the condition of steely or soft malleable iron; in either state the metal so refined may be poured from the vessel or chamber into suitable ingot moulds for the purpose of being afterwards hammered, tilted, or rolled into bars, rods, or plates, by the processes already known and practised in the manufacture of iron and steel. The patentee remarks that he has found in some cases that the ingots of metal contained cells or cavities; in such cases he subjects the ingot at a welding heat to the action of a "squeezer," such as is used in the shaping of puddle-balls; or he subjects the ingot to repeated blows in a suage or die under a powerful hammer, so that the parts are forcibly squeezed, pressed; or driven together, and the pores closed and the surfaces united or welded together, prior to subjecting such ingots to the rolling-mill or tilt-hammer. In carry-

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ing into practical operation this part of the invention, it will be necessary for the workman to bring up the ingot or mass of metal to such a temperature as will soften it sufficiently to allow the cavities in its interior to close up and unite, so as to form it into a compact solid body. When using a machine of the kind used for squeezing puddle-balls he prefers to form transverse grooves both on the lower and upper jaws of the "squeezer." The workman after having heated the ingot holds it with a pair of tongs in the groove of the lower block, while the upper one falls upon it with such force as the man who works the hammer may consider necessary. By the use of these grooved surfaces or suages the cast ingot of metal is less liable to be broken than when hammered between two parallel flat surfaces, which do not afford any support to the sides of the ingot; the workman will move the ingot backward and forward, and turn it over on its other side, and thus work and compress the metal until he judges that it is sufficiently solidified to be suitable for the tilting or rolling mill. the shape of the ingot being hexagonal in cross section instead of square, as in the former case, a more perfect support to the sides of a square bar is however obtained, by using a suage of the form in which a square or nearly square notch or groove is formed; in the lower block, a corresponding raised projection is formed on the upper or hammer-block, by means of which the tendency of the sides of the ingot to crush out is to a great extent prevented; however, it will be found that in all these shapes or modifications of the suage or forging surface that the metal, although considerably protected from spreading and giving way laterally, is at liberty to extend itself in the direction of its length, and is therefore liable to be driven out in that direction, and thus escape from much of the force of the blow, and also to become broken. To obviate these disadvantages a die or cavity is used, in which the metal is placed, so that when an ingot or other mass of metal, refined as hereinbefore described, in a soft or welding state, is put into the die it may receive the most powerful blows or pressure without its parts being broken or scattered about, but it will, on the contrary, be retained within the said die, cell, or cavity, and become there consolidated, and have its pores so closed and united so as to be in a condition suitable for the ordinary forging or rolling process. This effect may be produced by several different modifications of apparatus, the details of which are not of much importance, provided that the dies are so constructed that the ingot or mass of cellular or spongy malleable metal, whether iron or steel, be so confined within the said die, cell, or cavity, that when a plunger or hammer is forcibly brought in contact with it it may thereby be prevented from being dispersed or spread out, but will, on the contrary, be so retained in the said die, cell, or cavity, that it will, by the force thus brought to act upon it, have its various parts forcibly squeezed, pressed, or driven together, and the pores closed, and the surfaces united or welded together.

Having described how malleable ingots of iron or steel are to be made by a direct process of refinement from crude iron without the application of heat or fuel to the iron during the process, except such heat as is generated by the introduction of oxygen into the metal, we will now describe a modification of the process by which the patentee prepares the iron for conversion into steel of a superior quality. For this purpose the patentee proceeds, in the first place, to refine the crude iron in the manner hereinbefore described, carrying on the process until the most complete refinement is effected, and the iron is as nearly pure as may be; he then pours the fluid iron into water, by which it becomes granulated, and the grains or shots so produced are afterwards to be converted into steel by the process of cementation with charcoal in upright retorts, in the manner described in a patent granted to Mr. Bessemer for improvements in the manufacture of cast steel, and mixtures of steel and cast iron, and bearing date June 18, 1855;* the blister steel so produced may be melted in crucibles, as at present generally practised in the manufacture of cast steel, or by any other suitable means.

Claim.—The conversion of molten crude iron or of re-melted pig or finery iron into steel or into malleable iron without the use of fuel for re-heating or continuing to heat the crude molten metal, such conversion being effected by forcing into and among the particles of a mass of molten iron currents of air, or gaseous matter containing or capable of evolving sufficient oxygen to keep up the combustion of the carbon contained in the iron till the conversion is accomplished.

NEW FORMULA FOR FINDING THE VELOCITY OF WATER IN PIPES OR RIVERS.

By JOHN NEVILLE, C.E., Dundalk.

$$v = 140\,(rs)^{\frac{1}{2}} - 11\,(rs)^{\frac{1}{3}}.$$

In which v is the velocity, and r the "hydraulic mean depth," in feet; the "hydraulic inclination" being represented by s. The formulæ in common use give the value of v at from $94\sqrt{rs}$, to $100\sqrt{rs}$, which are only correct for velocities varying from 18 inches to 2 feet. The above formula has been determined from thirty-six experiments on all descriptions of channels with velocities varying from $\frac{1}{10}$-foot up to 21 feet; the expression for which in the ordinary form would vary from $52\sqrt{rs}$ up to $121\sqrt{rs}$, clearly demonstrating that the forms in common use are wholly inapplicable to any velocities but those between 1·5 and 2 feet, or thereabouts. The four following experiments will show the accuracy of the results.

No.	Value of r.	Value of s.	Velocity calculated.	Velocity observed.	Name of Experimenter
1	·052083	·000079	·105	·100	Leslie.
2	2·427200	·000063	1·143	1·166	Watt.
3	·021250	·814000	15·617	15·667	Neville.
4	·020833	1·400000	20·6	21·6	Hodson.

The formula being one for finding the effects of friction, the usual reductions for the orifice of entry, and bend, if any, are to be made before finding the value of s from the head and length of the pipe. With these necessary corrections, the formula is equally applicable to short and long pipes as to rivers.

PREVENTION OF THE SMOKE NUISANCE.*

THE Council of the Society of Arts having offered a special prize of a gold medal for an essay on the best means of preventing the nuisance of smoke arising from fires and furnaces, Mr. C. Wpe Williams was declared the successful competitor, and his essay has just been published. Mr. Williams, who is well known by his previous publications on the combustion of coal, has done good service by showing the proper requisites for the combustion of fuel, and the most successful endeavours yet made to avoid the smoke nuisance have been based on his plans. In the present essay he embodies the views taken in his former work, with such additions as further reflection and subsequent experience have suggested, and he now presents the subject in a more comprehensive and yet more compact form. He enters thoroughly into the chemistry of combustion, so far as is suitable to a popular exposition, and he points out very clearly by numerous analytical diagrams the principles according to which any system for the prevention of smoke should be regulated.

The essay is divided into ten sections, in which the author notices the various plans put forth as remedies,—the avoidance of the formation of smoke by the proper introduction of atmospheric air into the furnace—the nature and properties of smoke—the practical application of the principles explained—and, lastly, the legislative measures applied to the prevention of the smoke nuisance. In the course of these disquisitions, Mr. Williams deals very severely with the new Act of Parliament for the "consumption" of smoke, and he points out the absurdity and injustice of imposing penalties on persons for not burning what is actually incombustible. The inventors who have obtained patents for the consumption of smoke also come under the lash, for they ignorantly profess to do what is absolutely impossible. The black clouds of smoke issuing from the chimney of a steam-engine furnace, that darken the atmosphere and seem densely charged with carbon, when analytically examined are found to consist almost entirely of incombustible gases and steam, the products of combustion, the quantity of carbon being in the proportion of only 6 to 286 by weight. The quantity of carbon in a cubic foot of black smoke does not, in fact, weigh a single grain. The folly of the attempt to prevent the smoke nuisance by burning this minute portion of carbon, surrounded by a large volume of incombustible gas and vapour, becomes at once apparent when it is known that a cloud of dense smoke contains less combustible matter than a cloud of dust. In order to remove

* 'Prize Essay on the Prevention of the Smoke Nuisance.' By CHAS. WYE WILLIAMS, Assoc. Inst. C.E. London: John Weale. 1856.

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any doubt that may arise as to the possibility of so small an amount of carbon giving a black colour to so large a volume of smoke, Mr. Williams adduces the experiment, that when a single grain of lamp-black is carefully mixed with a small quantity of gum-water, and then poured into a gallon of water, the fluid becomes as black as ink. Mr. Williams's plan for abating the nuisance is *to avoid the formation of smoke*, by supplying the heated gases in the furnace with a suitable quantity of air diffused through a large number of holes. This plan, which was practically applied so far back as 1839, is now coming into general use; and if skilfully applied, it produces the effect of a perfect combustion of the fuel. It is not enough to provide an ample supply of air through the ash-pit, for the oxygen then becomes exhausted in passing through the incandescent fuel by the combustion of the coke, and the inflammable gas—the carburetted hydrogen evaporating from the coal—escapes into the atmosphere unconsumed from the want of air. Neither is it desirable to admit a large supply of air through the doors above the fuel, for in that case the heating effect of the furnace is diminished by the cooling influence of the over supply. A plentiful admission of air at the bridge of the furnace, diffused through a great many small apertures, is the principal remedy recommended by Mr. Williams for the prevention of smoke; but this specific will not be efficacious unless a judicious supply of air be also admitted through the bars and through holes in the doors of the furnace. There are other arrangements to be taken into consideration, such as giving ample space between the fuel and the boiler, providing a sufficient exit for the gaseous products of combustion, and properly regulating the supply of fuel. Unless these matters be attended to, the attempts to prevent the smoke nuisance will be more or less failures, however well-adapted the furnace may be in other respects "to burn its own smoke."

The following observations show that the perfect combustion of coal cannot be attained without attention to several other requisites in addition to the supply of a sufficient quantity of air:

"The prevailing inattention of engineers to those details which involve the quantity, place, and mode of admission of the air may be traced in a great measure to overlooking the fact, that in the use of coal there are two distinct classes of combustibles to be dealt with,—namely, the *gaseous* constituent, and the remaining *fixed carbon or coke;* each requiring its own separate supply of air, not only at *different times*, that is, successively, but at *different parts* of the furnace. Further, that as the gas itself contains two separate elements—hydrogen and carbon, these also require to be consecutively supplied with their respective equivalents of air. These constituents may be thus shown.

Each pound weight of good coal will give out 5 cubic feet of *gas*, and require for its special use 50 to 60 cubic feet of air, according to the quality of the gas; while the remaining *coke*, being about 50 to 60 per cent. of the gross weight of the coal, will require an addition of about 100 to 120 cubic feet. The products from each hundred-weight, then, in round numbers, will be as follows:

Hydrogen	5 lb.
Carbon in combination with the hydrogen, and forming the gas	20 lb.
Carbon remaining as coke	60 lb.
Nitrogen, sulphur, oxygen, and ashes	15 lb.
	100 lb.

We here distinguish the *three* bodies into which the coal is resolved, and each requiring its own special equivalent of air, viz.—The coke, the hydrogen, and the carbon of the gas. Now, the whole question of perfect or imperfect combustion,—the utilisation of all the elements of the coal, and obtaining their relative and entire calorific effect, will be determined exclusively, and absolutely, by the facilities afforded these three bodies in obtaining their respective contact and quotas of the air supplied.

It will not be enough, therefore, for engineers to look to the naked fact, that each pound of coal will require 150 cubic feet of air, and to expect that all the contingencies of combustion will be satisfied, *if they provide that quantity*. So far from that being the case, it is exclusively on the *special application* of the 150 cubic feet to these *three separate portions* of each pound of coal, as above described, that success will depend. For, if the air be taken up by the incandescent *coke* (and to which it first finds access) more rapidly, or in greater quantities, than the *gaseous* matter can simultaneously be supplied with *its own due quantity*, the entire operation in the furnace will be deranged. In a word, the gas should have its own equivalent of air, and enter into combustion as rapidly as it is generated, and in due relation to the combustion of the coke *in equal times*.

From these facts we obtain the necessary data which are to determine the areas of the several parts of the furnace: first, for the admission of the air to the incandescent fuel on the bars; secondly, for the *ingress* of the air to the two constituents of the evolved gas; and, thirdly, for the *exit*, or escape, of the volatile products of *both the coke and the gas* to the chimney shaft, and their due current through it."

Speaking of the nature and properties of smoke, Mr. Williams says:

"This black cloud is *tinted, literally but tinted*, by the atoms of carbon, and which, though issuing in countless myriads, are comparatively insignificant in weight or volume, or in commercial value as a combustible. In truth, the eye is deceived as to the mass by the extraordinary colouring effect produced by the minuteness, but great number, of its atoms of carbon.

"And now as to the relative *quantities* of the several constituents of smoke: 1st, of the *invisible nitrogen*. As atmospheric air contains but 20 per cent. of oxygen the remaining 80 per cent. being the *nitrogen*, passes away, invisible and uncombined. If, then, a ton of coal requires, absolutely, for its combustion the oxygen of 300,000 cubic feet of air, the 80 per cent., or 240,000 cubic feet of invisible and incombustible nitrogen, forms the first ingredient of this black cloud. 2nd, of the *invisible carbonic acid*. This portion of the cloud may be estimated as equal in volume to the 20 per cent. of oxygen which had effected the combustion of the carbon *both of the gas and the coke* of the coal. 3rd, of the *invisible steam* formed by the combustion of the hydrogen of the gas. In this will be found the great source of the prevailing misapprehension; yet no facts in chemistry are more accurately defined than those which belong to the formation, weight, and volume of the constituents of steam."

Mr. Williams points out the absurdity of some of the contrivances recently patented for burning smoke, by passing it through incandescent fuel without an additional supply of air. He also rejects the plans for burning smoke by mechanical arrangements —in fact, by any plan but his own; and yet it appears from his own exposition, that the best arrangement for the supply of air may be defeated by an improper supply of coal to the furnace. The dimensions of the furnace constitute an important element in the proper combustion of fuel, and Mr. Williams recommends an enlargement of most of the spaces where the supply of air is admitted. The essay is illustrated with several diagrams, showing the modes of construction to be avoided, and those recommended; but they are nearly the same as those explained in the author's former treatise.

VITRIFIED *VERSUS* POROUS DRAIN PIPES.*

A *brochure* of some half-hundred pages in the form of a pamphlet on this subject has been put into our hands, that to those who have given any consideration to the subject will be looked upon as a superfluity: it is the evidence, chemical, scientific, and practical, for and against the use of pervious or baked pipes for sewerage, in lieu of those which, being well burned or vitrified, are rendered non-porous. That such a question should arise again, or become necessary to be re-argued, is really the wonder.

Dr. Miller, Professor of Chemistry, King's College, says of the baked pipes, that they are "extremely faulty and porous," and "that instead of improving, the pipe would progressively deteriorate by the action of liquids upon it."

Professor Way, Royal Agricultural Society, says, that "from the experiments detailed, he is led to believe that the influence of sewage-water upon it (the porous pipe) would be anything but beneficial."

Dr. Thornton, Medical Officer of Health for Marylebone, says, that in order to prevent what would be equivalent to a cesspool, (the passing of fluids through a porous material), he has "required that brick drains should be abolished as much as possible, and their places taken by stoneware pipes."

There is, then, a mass of valuable evidence in favour of the vitrified or stoneware pipes from Messrs. Roe, Rawlinson, Pigot Smith, Lovick, Grant, Cresy, Pilbrow, and Donaldson, all civil engineers of large practice in this particular branch; and lastly, our valued cotemporary, the *Builder*, says: "If the public, with their eyes fully open to the fact, will have the inferior article at the lower price (a paltry saving of ten per cent.), and will drink out of a red pipkin when they can get china teacups, there will be no difficulty in gratifying their tastes."

Mr. Cresy says, that "he has examined a very great many specimens of ancient pottery of all ages, and he has found its preservation always in exact proportion to its hardness and im-

* Vitrified *versus* Porous Drain Pipes. London: Reynell and Weight. 1856.

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permeability; glaze being no protection to a soft body, which becomes, after a few years' interment, perfectly friable; whilst a hard body, even unglazed, resists both atmospheric moisture and damp earth, in a remarkable manner."

Mr. Pilbrow says, that he considers "nothing but a first-rate imperishable and well-glazed pipe, well jointed in cement, can be satisfactory."

About two years since the water which supplied a large establishment, the resort of the nobility and gentry, became gradually so bad that its smell and taste were both disgusting. It had been a fine spring, and with cost and care had been searched for and sunk to, and a deep covered-in well had been erected around it; but in connexion with the same establishment there were seven water-closets, and with so little precaution were the sewers from them executed, that they were built of porous, though good brick, and being only five or six yards from the well, in time the exudations (which a respectable evidence in favour of the porous pipes says would be, in a degree, filtered!) completely impregnated the earth-backing of the dry wall of the well not only on the high level of the sewers, but down through, even to mix with the fresh water supply to the pumps! As the lifting of the whole contaminated earth-backing of the well was out of the question (however desirable), if other relief could be given, it was suggested that a kind of compromise might be effected, and, that if the sewers or pipes from the water-closets and sinks could be rendered completely water-tight, so that no more of the sewage flow might extend to the well, the natural filtration and the moss-packing of the well walls would do the rest. Accordingly, as impervious pipes could not be obtained in that part of the country without great delay and difficulty, a quantity of plastic or potters'-clay, which was plentiful in the vicinity, was procured; and, clearing out the flagging of the bottom of the sewers, which were fortunately built rather large for the purpose they were intended for, a good bed of the well worked clay was laid in, affording it the soundest tiles that could be procured; the side walls were then lined with brick, backed also with a good coat of the potters'-clay, the joints of the brick being cleaned out and made good with Roman cement. The covering flags were then laid on, crowned also with a coat of the clay worked into connexion with the sides, which, it will be seen, rendered each sewer an impervious pipe, and although there was no opportunity of clearing away more than the worst of the saturated earth from the well, the proceeding was perfectly successful, and the water recovered its name, fame, and purity.

The question then of pervious or impervious vitrified pipes for sewers, independently of the everlasting quality of the latter, is scarcely one of taste—the difference of ten per cent. cost being a mere bagatelle.

THE DRAINAGE OF THE METROPOLIS.

The Metropolitan Board of Works sat on the 26th ult. A supplemental report was read by Mr. Bazalgette, the engineer of the Board, on the northern and southern drainage of the metropolis; in obedience to a resolution of the Board on the 12th of August last, which referred back to him his previous reports, in order that he might report to them anew on the whole question. Mr. Bazalgette states in the document that the metropolitan drainage scheme, as originally propounded by him, is capable, without any material alteration of design, of being adapted to a variety of points of outfall into the Thames, at various distances below London, or to the deodorisation or utilisation of sewage. Although the sewage of London cannot at present be profitably applied to agriculture in a commercial point of view, it may be advantageously deodorised and rendered inoffensive at Barking-creek and Woolwich marshes, or even nearer to London, and the Thames thus purified at less cost than by constructing sewers to a great distance below the metropolis. He is still of opinion that, in the absence of deodorising works, the sewage may be discharged into the Thames without nuisance at Halfway Reach, beyond the limits of the metropolis, in the manner already proposed for the south side of the Thames. Various propositions have, however, been made with regard to the position of the outfall and mode of discharge into the river, and with respect to the application of the sewage to agriculture. There appear to him to be four different modes by which the metropolitan sewage may be disposed of:—1. By retaining the points of outfall originally proposed at Barking-creek and Woolwich marshes, but dispensing with the reservoirs at those places, and substituting for them deodorising works, and discharging the purified waters into the Thames at all times of the tide, after having abstracted from them the deodorised manure, which would be available for agricultural purposes. 2. By discharging the sewage into the river at Halfway Reach, beyond the limits of the metropolis, at and near high water, so that it should not reflow up the river within the limits of the metropolis, excepting on occasions of heavy storms, which occur on from twenty to thirty days per annum, and last for short periods only on those exceptional days, on which occasions the sewage would be highly diluted. 3. By discharging the sewage into the river at Long Reach during the first half of the ebb-tide, reducing the capacity of the reservoirs, and preventing the reflow of the sewage into the river within the limits of the metropolis. 4. By conveying the sewage on the south side of the Thames underneath that river to the north side, and discharging it at Sea Reach at all times of tide, so that it would not return within the limits of the metropolis, and dispensing with reservoirs, or by occasionally distributing such sewage, or any portion thereof, as liquid manure over the lands or marshes through which it would be conveyed on its route to this outfall. The extension to Halfway Reach would involve an increased expenditure of 845,130*l.*; to Long Reach, 918,060*l.*; to Sea Reach, 1,763,824*l.*; and the addition of deodorising works to the original scheme, 1,273,480*l.* The substitution of deodorising works for reservoirs at Barking-creek and Plumstead marshes would involve the smallest expenditure of capital, but the largest annual outlay. A further saving of probably 500000*l.* might be effected by terminating the sewers and establishing deodorising works nearer to London, say in the Greenwich marshes on the south side of the river, and the West Ham marshes on the north side, which would, in his judgment, accomplish the object desired without creating a nuisance. He was still, after mature consideration, of opinion that the second proposition, or the extension of the outfalls to Halfway Reach would fully satisfy the requirements of the Legislature, and be effective in a sanitary point of view, as already explained in his former reports upon this subject. Mr. Bazalgette considers the proposal he has made would be equal to carrying off the entire drainage and the rain-water of the metropolis; he gives the preference to his second proposition. The report was ordered to be taken into consideration at a special meeting of the Board. Mr. Leslie gave notice that he should move that the report be entirely negatived.

LEICESTER ARCHITECTURAL AND ARCHÆOLOGICAL SOCIETY.

The annual meetings of this society were held during the past month. The first business was the election of Lord Berners as one of the presidents of the society, and of Lord Alwyne Compton as an honorary member. At the meeting a great variety of objects, architectural and archæological, were exhibited, including various designs by Messrs. Ordish, Millican, Flower, &c.; also some specimens of stained glass, and of ecclesiastical drapery, sent by Messrs. Jones and Willis. A truly antiquarian paper was read by Mr. Thompson on "Leicester Castle," and a more practical one by Mr. Millican, on the "Use of Ornamental Brick in Street Architecture," in which he mentioned that Leicester stands upon a bed of clay, eminently fitted to produce ornamental bricks, and advocated their more general adoption, since "in buildings where much ornament was not required bricks of different shades might be introduced, and the brick so arranged as to form patterns, and in higher classes of erections mouldings of various forms might be adopted, and this without much increase of expense."

A short paper was next read by the Rev. J. M. Gresley, describing a remarkable tomb in the church of Ashby-de-la-Zouch, which, with the usual discussions, occupied the day.

On September 10th the annual excursion was made, the neighbourhood of Melton Mowbray being the locality selected. The party first visited the magnificent parish church, which was described in its most peculiar features by the Rev. J. Sandilands. It is a large cruciform structure, unquestionably the finest in the county. In details there is a variety, and each of the three Gothic styles is admirable exemplified. The tower is, perhaps, the most valuable in point of design. The lower part is Early English, and a very pure specimen. At each angle, in place of a buttress, the wall has a slight projection, finished by a cylindrical moulding on the sides, and banded by a prolongation of the abacus of the capital near it; the span between, receding a little, is overhung by a corbel table, and on each face of the tower is a triplet of windows. These windows are deeply recessed, of equal height, and of two lights each; the tracery is geometrical, and in the jambs are three banded shafts, separated by a line of the dog-tooth ornament.

Another part of the edifice, possessing more than ordinary attraction, is the *Galilee Porch*, in which the sculptured and ornamental work is peculiarly rich and excellent.

The excursionists next proceeded to Burton Lazars (so called from a hospital for *lazars*, or leprous persons, formerly existing there), and afterwards to Little Dalby Hall, which is undergoing considerable alterations and additions, from the designs of Mr. Alfred Bell, of London. A large amount of polychromatic decoration has been introduced internally, and with great judgment. Continuing their travels the party reached Burrow Hill, Great Dalby, and finally Kirby Belers.

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NOTES OF THE MONTH.

St. Alban's, Wood-street, City.—This church has been receiving considerable additions and improvements, under the direction of Mr. G. G. Scott, and is now reopened. An octagonal apse, forming a suitable chancel, is the principal new feature; this is ashlared fair both without and within, and has an elegant stone-groined ceiling springing from shafts in the angles. The carving of the bosses, &c., by Mr. Earp, is very good. In each side of the apse is a two-light window, with perpendicular tracery, and now filled in with rough cathedral glass. The floor is laid with plain tiles. The body of the church has been cleaned, the organ re-arranged, and some of the unsightly fittings displaced, but the curious hour-glass is retained in its old position near the pulpit. These alterations have been executed by Mr. R. Robinson, of Whitechapel.

St. Anne's, Soho, London.—The burial board of this parish have just appropriated a building free of charge (the first of the kind in the metropolis) for the reception of the dead previous to their interment. It immediately adjoins the parish church, and is open daily to the inspection of visitors. The object is stated to be the prevention, as far as possible, of the spread of diseases—epidemics in particular,—which are so frequently engendered by the proximity of corpses to living-rooms. The rooms are to be at any time open to the relatives of the dead in their temporary resting-place, which is watched, by an attendant appointed for the purpose, day and night.

Windsor.—The land for the new cemetery chapels here has been staked out for the erection of the plans submitted by Messrs. Poulton and Woodman, of Reading, which have been approved of by the town council. The style of the chapels is Decorated, to be executed in ragstone, with Bath dressings. The roofs are open-timbered, and a porch of the same material is appended to the Dissenters' chapel. The Episcopal chapel has a turret and slender spire. Internally a new feature is to be introduced, and we hope successfully,—viz. the enriching of some of the blank walling by means of stone panelling, to be eventually filled in as tablets or for suitable inscriptions.

White Knights, near Reading.—This celebrated estate, formerly belonging to the Duke of Marlborough, and one of the most charming spots in the kingdom, is once more notified as disposed of for building purposes, and villas, with an allotted number of acres of ground to each, will be ultimately erected. It may be remembered that this scheme was set on foot some twelve or thirteen years since, and competition designs for the laying out advertised for, when those sent in by Messrs. Scott and Moffatt were selected, and obtained the first premium. Difficulties, however, arose in connection with the late proprietors of the grounds, and the idea was necessarily postponed. It does not transpire what the intended arrangement is to be like, but we sincerely trust that a due regard will be maintained for a spot which nature and art have combined to render hitherto so attractive.

Oxford.—Two more stone coffins or "cists" have been discovered during the past month at Christ-church Cathedral, Oxford. On the lid of one is a cross, terminating at each point in a plain heavy ornament in the form of a solid triangle; the other has no ornament except a moulding round the edge. They were found deposited in the middle aisle of the choir, and are very ancient. A few old coins have also been found.

Worksop.—It is creditable to the taste and spirit of the working classes of Worksop, that they are now subscribing to supply the large wheel window in the gable of the east end of the church (newly restored), with stained glass.

St. Mary Magdalene, Taunton.—It is no secret that the magnificent tower of this church, unquestionably the finest of its class in the west of England, is in a highly dangerous condition, owing to the decay of the stone, and the alarming fissures which have gradually manifested themselves. It has been a question whether the whole shall be taken down and rebuilt, as a faithful reproduction, or whether there is any possibility of maintaining the present structure. The majority of judges fear the latter will be impracticable. Funds, we regret to learn, are among the obstacles to active proceedings. A letter has just been addressed to the churchwardens, suggesting the following plan, on the presumption that the larger number of persons are favourable to the idea of rebuilding,—a work which must necessarily occupy some considerable time. It states, "I am not aware that my responsibility in this matter exceeds that of others; but feeling anxious to relieve myself from my share, whatever it may be, and being grieved at and ashamed of the inertness which seems to cramp the energies of those who should be active in the work—in which number I, of course include myself—I feel constrained to make an effort, and I therefore offer towards the cost of rebuilding the tower an annual subscription of 100*l.* for five years, to be paid on a fixed day in each year, and to be legally secured." The payment of this subscription is proposed to be subject to the following conditions:—1. That the whole sum required, including what may be contributed by rate, shall be secured at or before Easter, 1857; 2. That, as nearly as possible, a fac-simile of the present tower shall be erected.

Faversham.—It is found impracticable immediately to carry out the whole of the alterations recommended in this church, but it is proposed to carry out the entire improvements to the tower and western end of the church, and also to erect a gateway and gates at the southern entrance to the churchyard. The cost will probably be something like the following:—The 1st, 2nd, and 3rd stages of the tower, 1320*l.*; gates and southern gateway, 200*l.*

Manchester.—To the Salford Royal Museum and Library a new wing is about to be added from the designs of Messrs. Travis and Mangnall. Several estimates had at various times been submitted, but all came out too high. Now, however, one by a local builder, named Harrap, has been adopted: the amount is 2552*l.* There is to be a large upper room devoted to local exhibitions, and a ground-floor to be divided into two to contain framed engravings, drawings, and small paintings. The new corridor is to be devoted for casts from the antique, statuary, &c. The basement is for the geological collection, and for models of machinery, works, and other large objects. In addition to forming this new wing, it is intended to pull down the present old and dilapidated portico on the east front, and to build another. The design is Doric, entirely stone, and shows four fluted columns, with a broad flight of steps approaching from the front only. As a statistical matter, it may be added that the average number of visitors to the museum is about 2000 a-day.

Leicester.—A subterranean vaulted passage has just been discovered near the lower end of Trinity Hospital. It is 11 feet wide, and 10 feet high, and extends some distance under ground. It is 8 or 10 feet below the surface. The upper part is arched, and the whole is built of stone.

Liverpool.—A new Roman Catholic cathedral is about to be built in Liverpool. Mr. Walter Pugin is the architect, and it is said that the edifice will be of the most gorgeous description.

Sprotborough Church, near Doncaster.—This church, which has just been completed, owes its erection to the liberality of Sir Joseph Copley, and has been designed on the model of Skelton church near York, but adopting, instead of Early English, the succeeding or Geometrical style. In its arrangement it consists of a nave of three bays, with corresponding narrow aisles, the separating arcade having circular piers. The chancel is of the same width as the nave, and has also two aisles in continuation of those of the nave. Between these aisles and the chancel are, on each side, two arches with richly moulded details. Thus the general form of the plan constitutes a parallelogram of about 70 feet by 40 externally, unbroken, except by the south porch, which, as at Skelton, is an important feature in the design, and has a deeply-recessed and shafted doorway, also a stone-ribbed roof. The nave, chancel, and aisles are spanned by one roof of nearly equilateral pitch, but the junction of the nave and chancel is marked outside by a stone bell-turret, containing two openings under one comprising arch. The side windows are single lancets, cusped; the east is of three lights, and traceried; the west end has two long two-light windows filling up the whole width of the nave, and over them a circular window. The stone used is local, and the church is ashlared internally; the roofs are plain, open, and of oak. The carving is throughout unusually excellent. The architect is Mr. Gilbert Scott, of London.

Islip Church, Northamptonshire, a very pure example of Perpendicular architecture, has lately been worthily restored under the direction of Mr. W. Slater, of London; and Stanwick Church, not far distant, and curious for its west-end steeple, of which both the spire and tower are octagonal, is now undergoing a like renovation, which is expected shortly to be completed.

Norfolk and Norwich Archæological Society.—This society met at Great Yarmouth on the 3rd ult., and after the preliminary business at the town-hall, commenced a journey through the adjoining hundreds of East and West Flegg. They visited in succession Caistor Castle, an ancient and venerable ruin (the stronghold of Sir John Falstaff in the 15th century), and then the parish churches of Filby, Burgh, Martham, Ormesby, &c., which completed the day's excursion.

Belfast.—The foundation stone of a new church has just been laid near Holywood, on a site granted by Miss Symes, of Glencraig. It promises from the drawings to be a handsome structure in the Gothic style, with a tower 60 feet high, which will form a marked feature in the undulating landscape.

Bolton.—A new Unitarian chapel (Early English), costing altogether 3900*l.*, was opened at Bolton on the 21st of August.

Balmoral.—The old castle of Balmoral is now a heap of rubbish, and the new building stands alone, without any other near it to interfere with the effect. The new castle is, however, yet far from complete, and it was only a week or two since that the royal standard floated for the first time from its tower. There is also much to do in the offices and stables; the latter are not near finished. The bakery has been completed, and the whole range of this portion of the building will be finished in just the same style as the castle proper, including the little projecting towers and their high-peaked roofs. By far the finest view of the castle is obtained from the other side of the Dee; and any one travelling from Aberdeen to Castleton will see the exterior to advantage from three separate points of view.

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Boston.—A valuable addition to local archæology is announced in Mr. P. Thompson's 'History of Boston,' of which the first part is now issued. The price complete is to be, octavo 1*l.* 5*s.*, folio 2*l.* 10*s.* A brief history of the whole division of Skirbeck is also included, and the illustrations, by excellent artists, number 100. Besides the historical portion of the work, its architectural department is well sustained, and the index points to curious information respecting St. Botolph's monastery, the Carmelite, Augustine, and Franciscan friaries, St Mary's Priory, St. Ann's Hospital, &c. The ancient establishments known as *Guilds* appear to have been pretty numerous, as we find allusions to those of St. Botolph, Corpus Christi, the Blessed Mary, SS. Peter and Paul, Holy Trinity, St. George, St. James, St. Jude, St. Catherine, the Holy Apostles, the Holy Rood, the Fellowship of Mercy, the Seven Martyrs, and the Ascension. The villages in the neighbourhood of Boston which are chronicled and described are, Skirbeck, Fishtoft, Freiston, Butterwick, Benington, Leverton, Leake, Wrangle, Frith Bank, and Cowbridge; of most of which the churches, at least, present interesting specimens of architecture. A section of the book is devoted to geological inquiries, and to a lengthened notice of the geographical features of the "Fens."

Railways.—New railway projects in the South-east:—1. A line from Dartford, joining the North Kent line, to Vauxhall station, adopting the Surrey Canal route. 2. A similar line in a more southerly direction, through Camberwell, Peckham, and Clapham. 3. A line from Battersea to near Buckingham Palace, buying up the Grosvenor Canal. 4. A line from Lewisham to Dartford. 5. A similar but more extended line from Lewisham to Strood. 6. A line from Lewisham, St. Mary Cray, or Bromley, to Tunbridge. 7. A line from Maidstone *vid* Headcorn to Cranbrook or Tenterden.

Sheerness.—Messrs Kirk and Parry have received an Admiralty order to build the new military hospital within the fortifications at Sheerness. Preparations are being made for the immediate progress thereof under their contract, accepted by the Admiralty.

Pontoons.—Some experiments have lately been made at Chatham in pontooning before a Board of officers of the Royal Engineers, with the view of still further testing the strength and general efficiency of the pontoons invented by Major-General Blanchard, which are in use by the Royal Sappers and Miners, and also the merits of a new description of pontoon, the invention of Mr. Forbes, C.E. The experiments, which were witnessed by Lieutenant-General Sir Charles William Pasley, K.C.B., were carried out under the immediate direction of Major F. C. Hassard, R.E., the President of the Board. The merits of General Blanchard's pontoon, when required to be used on tidal rivers and against a powerful current, were tested. The spot selected for the experiments was that part of the river Medway lying between the present new bridge and old Rochester-bridge, the tide at this point being unusually rapid, which was the reason that part of the river was selected. There was a strong wind also, which, it was considered, would add further difficulties to the proposed undertaking; but notwithstanding this, the result of the experiments was exceedingly satisfactory. The pontoons were floated up from the Gun-wharf at Chatham Dockyard, through Rochester-bridge, to the space above, where they were moored. Each "raft" carried its proper complement of men and the necessary implements. General Blanchard's pontoon is made of block tin, of a cylindrical shape, and being hollow floats high out of the water. In a short space of time the rafts were formed into line, each raft being capable of sustaining a weight equal to three tons. The rafts were then lashed together, which operation having been completed in a few minutes, an immense floating platform was thus formed across the river, over which a body of soldiers, with the *matériel* of an army, could be marched four or even six abreast. Sir Charles Pasley was rowed to the pontoon-bridge in one of the newly-invented india-rubber pontoon-boats, which was propelled through the water with the greatest ease by one of the lieutenants of the Royal Engineers. The signal was then given for the pontoons to be "racked down." A 12-pounder brass gun with the carriage, weighing together two tons, was then wheeled backward and forward several times over the bridge without causing any sinking of the pontoons. The whole of the experiments, which were the first of the kind, were considered to be highly successful.—The experiments with the pontoon of Mr. Forbes were made at St. Mary's creek. The newly-invented pontoons, it is alleged, have a great superiority over those at present in use, they being of a triangular shape and somewhat less bulky, advantages which, the inventor considers, will have the effect of rendering them more buoyant, more easily managed, and capable of sustaining a greater weight than those of a cylindrical shape now used. During the experiments it was a matter of observation that Mr. Forbes's pontoons were not so steady in the water as General Blanchard's; and, being triangular, it was considered that they were more liable to get out of order and sustain injuries by the angular sides coming in contact with any substance either in or out of the water. Although the newly-invented pontoons will probably bear as great a weight as the present kind, yet from the experiments it was found that Mr. Forbes's pontoons are not so easily managed as General Blanchard's, it being very difficult to perform the operations termed "booming out" with them, a manœuvre easily and quickly managed with the present kind.

Pembroke Dockyard.—The present dry dock is being widened and lengthened, so as to meet the requirements of our new class men-of-war. Two new slips for ship-building are in course of erection; these are being made of huge blocks of limestone, with copings of granite. Other slips are being lengthened to meet the increased size of the ships, and the consequence is a great increase seaward of the establishment. An extension of the sea wall is going on. All accumulation of mud is to be washed away by means of reservoirs between the slips, and these can be run out by the sluices when required. The lengthening and widening of the dock will this year cost 10,000*l.*, and the new slips and boat basin will take 14,000*l.* The entrance of the dock is to be widened, at an expense of 5000*l.*

Francis's Corrugated Metal Wagons.—The experiments with Mr. Francis's wagons, which were submitted for trial before the authorities of Woolwich Arsenal, have been pronounced of so satisfactory a nature that they have expressed their decision of urging the government to decide on their introduction for all the purposes they may be applied to.

Graving Docks, Liverpool.—Mr. Laird's graving-dock, No. 2, capable of taking in vessels larger than the *Himalaya*, is now open, and Nos. 3 and 4 graving-docks will be opened within a fortnight. No. 3 is 420 feet long and 35 feet entrance; and No. 4, 450 feet long and 87 entrance; nearly 100 feet longer and 15 feet wider than the *Persia*.

Street Encroachments.—We are gratified to find that the Metropolitan Board of Works are resisting all applications for permission to convert forecourts of houses into shops, and the erection of porticos and balconies over doorways. The 143rd section of the Act empowers the Board to prevent the continuance of this nuisance. In order that each case may be thoroughly sifted, every application is forwarded to the district board in which the house proposed to be altered is situated, for the expression of their views, and nine out of ten of the local boards as resolutely set their faces against the enclosure of forecourts as the central board itself.

Military Locomotive Electric Telegraph.—During the recent autumn manœuvres in East Prussia the locomotive electric telegraph was introduced for the first time; it was invented and first used in Austria at the Olmutz manœuvres in 1853, at which the late Emperor Nicholas was present. It consists of a close omnibus-looking vehicle, drawn by horses, and containing an electric battery, together with a supply of metal wire, protected by gutta-percha, which runs off from a reel as the vehicle advances from the spot where the wire was originally made fast. This spot is the head-quarters of the commander-in-chief of the manœuvrer or of a hypothetical battle. The point to which the vehicle advances, "as the crow flies," is the advanced post of a general of division, or the extreme point of an outlying wing; and in its passage from one spot to the other pointed staves of some eight or ten feet in length, and provided at one end with the proper insulating bed for the wire, are let down at intervals from the vehicle. A sufficient supply of manual labour being at hand to drive into the ground these staves or poles on which the wire is supported, the electric communication may be said to be established as rapidly as the vehicle with its *matériel* can be conveyed from one part of the field of operations to the other, and certainly within a very few minutes of its arrival messages can be transmitted. It has also been used without supporting the wire on poles, by simply running the wire out and letting it lie on the ground.

St. Michael, Coventry.—A new stained glass window is in preparation by Messrs. Heaton and Butler of London, to occupy the east end of the north aisle of the above church, and to be as a memorial to the late Lord Hood, who fell in the Crimea, and who was for many years resident at Whitley, near Coventry. The window is of nine lights, of perpendicular character, and the subject selected for the glazing is the Ascension, the group of which is to extend across three of the lights, after the plan of some windows more usual on the continent than in England. In the remaining lights are to be figures of the lesser prophets, and also appropriate symbols.

St. John the Baptist, Glastonbury.—The promoters of the restoration of this church have recently issued a work entitled "A brief memorial of the Ecclesiastical Antiquities of Glastonbury," containing a concise account of the most interesting particulars in the history of the magnificent abbey now in ruins, and enriched with notes of high antiquarian value. The profits arising from the sale are to be devoted to the restoration fund.

Glasgow Cathedral.—A meeting has been held at Glasgow for the purpose of obtaining subscriptions to complete the restoration of the cathedral by filling the whole of the windows with stained glass. The recent restorations have cost about 17,000*l.*, and as they came to a close, it was deemed by many that it would not be complete unless the windows were filled in with stained glass in the very highest style of the art. A subscription was accordingly organised on the plan that each contributor should fill in one window, and it has been most successful. The four principal windows will cost from 800*l.* to 1000*l.* each. There are upwards of forty smaller windows, the filling in of which will cost about 120*l.* each, and these have been taken up by several noblemen, the great majority falling to the share of private citizens of Glasgow. When completed it will exhibit the finest specimen of modern glass-stained windows in the kingdom.

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New Public Offices.—The specifications and block plans are to be ready for delivery on the 1st of October, according to the announcement in the advertisements. It is stated that the first commissioner intends to give the greatest publicity to all the designs and models which will be sent in. The latest period for sending in the designs for the public offices will probably be extended to the 20th of March; and the latest period for sending in the models for the Duke of Wellington's monument will be the middle of June; and, in order that the public may witness the grand competition of native and foreign talent which will be displayed, Sir Benjamin Hall has intimated that the exhibition of the designs for the Westminster improvements shall be open to the public at Easter; that it shall close about the 1st of June, after being open six weeks, when Westminster Hall will be again required for the next exhibition of the models of the Wellington monument.

Wellington Monument.—Independently of one hundred and fifty specifications containing plans of St. Paul's Cathedral, which have been sent abroad, and about one hundred more which will be required for the same purpose, no less than two hundred applications have been sent in from architects, sculptors, and other artists, for copies of the specifications.

OBITUARY.

On the 1st ult., Sir Richard Westmacott, R.A., sculptor, in his eighty-second year, at his residence, South Audley-street, London.

Recently, Mr. Thomas Hopper, of London, aged seventy-nine, architect, and for about forty years county surveyor of Essex.

Lately, Mr. George Porter, district surveyor of Newington and the central division of Lambeth.

Recently, at his residence on Monte Caprino, Rome, Dr. Emile Braun, the well-known antiquary and secretary of the Archæological society of that city.

On June 6, at Luckie, Sivia, India, aged twenty-eight, Mr. Walter King, C.E., son of the late Mr. R. King, of Plymouth and Rigadon.

At the British Consulate, Margill, Turkish Arabia, aged thirty-four, Mr. Charles Rammel, C.E., son of the late Mr. Gibon Rammel, of Dent-de-Lion, near Margate.

ST. MARY'S CHURCH, OXFORD.

CONSIDERABLE apprehensions having been excited some months back as to the safety of the magnificent steeple of this edifice, in consequence of several indications of insecurity, steps were immediately taken to check further dilapidation, and to rectify, as far as possible, the damage already received, which appeared partly attributable to encroachments on the foundations in the shape of a large sewer. Three sets of wrought-iron tie-bars were, in the first instance, fixed at three different levels in the tower; each set consisted of eight bars, two being used in one length, flanged at their junction, and firmly drawn together by double-screwed connecting pieces. Care was taken in boring the walls for their insertion not to disturb the masonry more than necessary, and consequently a small auger was directed to be used for the purpose. The holes were afterwards filled in with Roman cement, and the exterior facing of such parts ashlared.

The next process to be accomplished was *shoring*. In this the best Baltic fir only was employed. Sleepers of large scantling were firmly bedded on the ground, concrete having been previously thrown in to the necessary excavations. The arches of the tower windows was strengthened by a series of framed and braced centres, and every precaution taken to preserve the mass of the fabric from being in any way shattered.

The tenders required for the works specified were based upon the following data, viz.:—

200 cube yards of concrete.

3200 cubic feet of timber for the shoring, including posts, sleepers, braces, centres, needles, and chocks.

35 cwt. say, of wrought iron for screw-bolts, and straps, fixed, as directed, to the shoring.

58 cwt. of wrought iron tie-bars, flanges, &c., for the three sets of ties to the tower.

We hear that these operations are now reaching a satisfactory conclusion.

COMPETITIONS.

The Burial Board of St. Paul's, Deptford, wish to receive designs for laying out the ground and the erection of two chapels, lodge, and entrance-gates. Outlay not to exceed 1600*l*. Premium, 25*l*. for the best design. Plan of the land and particulars may be obtained of the Clerk to the Board, High-street, Deptford. Designs to the 10th of October.

The Londonderry Bridge Commissioners are desirous of obtaining plans, sections, and specifications for a new bridge over the river Foyle, at Londonderry, to be constructed for the joint purposes of ordinary traffic, and carrying a railway across; also to contain an opening space of from 30 to 40 feet wide for the free passage of vessels, at a cost not exceeding 10,000*l*. To be accompanied by an estimate stating the gross sum for the entire work, and appended thereto a scale of prices upon which such gross sum has been arrived at. For the plan, &c., approved of by Sir William Cubitt as first in merit, a premium of 200 guineas, and to that placed by him as second in merit, 100 guineas. Particulars of Mr. A. H. Stewart, Clerk to the Londonderry Bridge Commissioners, Londonderry. The time for receiving the plans is extended to October 20.

Plans are required for laying out and preparing the grounds selected as the site of the New Cemetery, Gloucester. Plans of the ground and particulars may be obtained on application to Mr. John Harvey, Surveyor, Gloucester. Plans to be sent in by the 20th of October.

It is intended to erect a Column and Statue in honour of the late Duke of Wellington, at Liverpool, for which designs are required. The amount at present at the disposal of the Committee is about 6000*l*. and if their intentions can be properly carried out for that sum, they are desirous that it should be; but any artist will be at liberty to send in a separate design, either for the Column alone, or for a Column and Statue. The competitors must accompany their designs by estimates of the cost, either for the Column and Statue combined, or separately. A premium of 50*l*. will be given for the design which, in the opinion of the Committee, is the best for the purpose intended. All communications to be addressed to the Chairman of the Committee, at the Town-hall, Liverpool. Designs to be sent in by the 1st of November.

The Trustees for sale of a Freehold Estate of 500 acres, including the Beulah Spa, and near the Crystal Palace, require Plans for Laying Out the same for building purposes, showing the necessary roads, sewers, &c., the whole to be clearly defined and apportioned in suitable lots, and laid down to a scale of two chains to one inch, from actual admeasurement. The premiums offered are, for the approved plan, 150 guineas; for the second, 100 guineas; for the third, 50 guineas. Particulars may be obtained of Mr. Peacock, builder, near the Jolly Sailor Station, Norwood. The plans are to be forwarded to the Secretary's office, Auction Mart, London, addressed to the Trustees of the White Horse, Norwood Estate. The time for receiving them is extended to the 8th of December.

A Premium of 100*l*. is offered for the best Essay on the present condition and future prospects of Canals and Canal Conveyance. Essays to be sent in to Mr. Thomas Wilson, Honorary Secretary to the Canal Association, Aire and Calder Navigation Office, Leeds, to December 31.

The Committee for carrying out the erection of the Memorial Church at Constantinople, wish to receive designs for the same. The style to be adopted must be a modification to suit the climate, of the "Pointed" or Gothic. The church to be of sufficinet capacity to hold, without galleries, seven hundred persons, and the cost not to exceed 20,000*l*. Premiums, 100*l*. for the first, and 70*l*. and 50*l*. for the second and third, or in case of equality, two prizes of 50*l*. The Designs to be sent to the Honorary Secretaries of the Memorial Church, No. 79, Pall-mall, not later than January 1st, 1857.

The Commissioners of Her Majesty's Works and Public Buildings invite architects of all countries to furnish them with designs for Offices for the Secretary of State for Foreign Affairs, for the Secretary of State for War, and for laying out the ground between the Thames and St. James's-park, adjoining Great George-street. The drawings to be made to a scale of 16 feet to the inch. General specifications of the materials proposed to be used in the buildings must accompany each design. A block-plan showing how the site may be so appropriated that the two buildings proposed to be erected may form part of a large and comprehensive scheme for concentrating the principal public offices, and for the improvement of the leading thoroughfares, including Westminster-bridge, whether as regards its present or any other site. Seven premiums for the best designs for the War Office of 800*l*., 500*l*., 400*l*., 300*l*., 200*l*., 100*l*., and 100*l*. Five premiums for the best designs for the Foreign Office, of 700*l*., 400*l*., 300*l*., 200*l*., 100*l*. For the best design for a block plan, three premiums of 500*l*., 200*l*., 100*l*. Plans of the ground, and other particulars will be forwarded on application to Mr. Alfred Austin, Office of Works, Whitehall. Designs to be sent in by the 1st of February.

Designs are invited from artists of all countries for a Monument to be erected in St. Paul's Cathedral, to the memory of the late Duke of Wellington. The cost, with all expenses, not to exceed 20,000*l*. Premiums of 700*l*., 500*l*., 300*l*., 200*l*., and five of 100*l*. A ground-plan of the cathedral, and the site of the proposed monument, &c., will be forwarded, on application to Mr. Alfred Austin, Office of Works, Whitehall. Designs from artists residing in the United Kingdom to June 1st, 1857; from artists residing abroad to the 25th of the same month.

The Burial Board for the parish of Lewisham, Kent, have accepted the designs of Messrs. Tinkler and Morphew, architects, of 4, Mear-street-place, Cannon-street, for laying out the ground, and the erection of chapels, lodge, and entrance-gates on the new cemetery. The design is of the Early Decorated period.

The Designs of Mr. Isaac Thomas Schutt, architect and surveyor, Harrogate, have been selected for the New Workhouse for the Knaresborough Union.

The First Premium of 70*l*. for plans of Sewerage for the Garston District has been awarded to Mr. P. M. Coogan, Borough Engineer's Office, Liverpool; and the Second Premium of 30*l*. to Mr. Evans, Abingdon-street, London.

Twenty Designs were received for the Chapels on the New Cemetery at Windsor, and from these the Committee have selected one with detached Chapels, by Messrs. Poulton and Woodman, Architects of Reading. They will be in the Decorated style of Gothic architecture, of rag stone with Bath stone dressings. The estimated cost is 1350*l*.

The Premium of 50*l*. for the best plans for enlarging and improving Naas Gaol, has been awarded to Mr. John M'Curdy of Dublin. The cost will be about 9000*l*. A new wing is to be erected. The old wings to be connected by corridors to the central building, which will be converted into an inspection hall; the whole to be open from ground-floor to roof, with iron galleries to each story.

NEW PATENTS.

PROVISIONAL PROTECTIONS GRANTED UNDER THE PATENT LAWS AMENDMENT ACT.

Dated May 8.

1052. E. Thomas, Holywell-street, Millbank—Improvements in the construction of counting apparatus, for ascertaining and indicating the number of rotations made by shafts or spindles in various descriptions of machinery

Dated May 6.

1344. D. C. Dallas, Islington—Improvements in chemical preparations applicable to the photographic and photo-galvanographic processes

Dated June 9.

1371. W. Smith, Hastings, Sussex—A material for the destruction of flies, gnats, and other insects. (Communication)

Dated July 16.

1675. D. Bowlas, Reddish, Lancaster—Improvements in throstles, and doubling frames for spinning and doubling cotton and other fibrous materials

Dated July 23.

1748. H. Doubleday, Coggeshall, Essex—Improvement in the manufacture of starch

Dated July 25.

1765. G. Spencer, Cannon-street West—Improvements in the couplings of feed-pipes of locomotive steam-engines and tenders. (Communication)

Dated July 30.

1802. R. A. Brooman, Fleet-street—Improvements in ladies' skirts or petticoats and dress-improvers or bustles. (Communication from Madame Vernier)

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Dated August 2.

1828. R. A. Brooman, Fleet-street—Improvements in the manufacture of artificial fuel. (Communication)
1830. J. Rhodes, Nottingham—Improvements in machinery or apparatus for reducing turnips and other vegetable substances to a pulpous state

Dated August 4.

1832. J. Harris, Dolgelly, Merioneth—An apparatus for collecting and condensing smoke and gases generated in furnaces

Dated August 7.

1861. A. T. N. Goll, South-street, Finsbury—An improved button
1863. S. King, Brighton—Improvements in spirit lamps
1865. C. Wright, Green-street, Southwark—Improvements in the preparation of lubricating materials

Dated August 8.

1867. J. Leese, jun., Manchester—Improvements in machinery used for printing calico and other fabrics
1869. T. Austen, Waltham Abbey, Essex—Machine for ascertaining the propelling force of gunpowder
1871. W. E. Newton, Chancery-lane—Improvements in machinery for composing and distributing types. (Communication)
1873. D. Fehrman, Liverpool—Improvements in lamps adapted for burning resin oil. (Communication from F. Benkler, Wiesbaden)

Dated August 9.

1875. W. Webster, Bunhill-row—Improved valve-cock. (Communication from A. Van Horn, New York)
1877. E. Kopp, Paris—Improvements in the manufacture of gas
1879. E. E. Amyot, Paris—Improvements in the preparation of pulp for paper, pasteboard, and other uses for which pulp is required
1881. A. L. Reid, Glasgow—Improvements in producing ornamental figures or devices on textile fabrics and other surfaces
1883. G. Anderson, Queen's-road, Dalston—Improvements in the construction of taps or valves for regulating the passage of gas

Dated August 11.

1885. J. Cartland, Birmingham—A new or improved door spring
1887. R. A. Brooman, Fleet-street—Improved fermenting agent. (Communication)

Dated August 12.

1889. A. R. Janet, Perigueux, France—Certain apparatus for taking measure of coats
1891. J. W. Downing, Birmingham—Improvements in the manufacture of metallic and other wheels and pullers
1893. J. Hardaker, Leeds—Improvements in machinery or apparatus for stopping railway trains, which are also applicable for alarm signals generally

Dated August 13.

1895. R. D. Kay, Accrington, Lancaster—Improvements in machinery or apparatus for washing, scouring, cleaning, preparing, dyeing, or finishing, woven fabrics, yarns, or threads. (Communication)
1897. J. B. Clara, South-street, Finsbury—Improvements in producing and employing steam and the gaseous products of combustion for obtaining motive power

Dated August 14.

1899. E. Hallen, Cornwall-road, Lambeth, and W. H. Kingston, Bandon, Cork—Improved means for making signals on railways
1901. J. Knowles, Holcombe Brook, Lancaster, and W. Clarke, Manchester—Improvements in looms for weaving
1903. W. Morgan, Gloucester-terrace, Hyde-park—Improvements in the manufacture of guns and mortars
1905. P. A. Godefroy, King's-Mead-cottages, Islington—Improved treatment of the matrix of rock quartz and all like substances, for the extraction of auriferous argentiferous, and other metals contained therein.

Dated August 15.

1907. J. B. Smith, Manchester—Improvements in machinery for preparing, spinning, and twisting cotton and other fibrous substances
1908. H. C. Hurry, Wolverhampton—Improvements in railway crossings
1909. H. A. Jowett, Sawley, Derby—Improvements in rails and railway chairs, and in the construction of railways
1910. C. S. S. de Kis-Geresd, Widnes, near Warrington—Improvements in obtaining motive power
1911. C. R. Skinner, St John's, Worcester—Improvements in tanning and finishing off leather
1912. H. Duba, Vulcan Foundry, Warrington, and J. Evans, Haydock, Lancaster—Improvements in effecting the consumption of smoke

Dated August 16.

1913. W. Tranter, Birmingham—Improvements in fire-arms
1914. W. Hargreaves, Bradford, York—Improvements in Collier's combing machine, in combing wool, hair, cotton, silk, flax, and other fibrous substances
1915. G. Slater, J. Williams, and S. Whitaker, Burnley—Improvements in power looms for weaving
1916. D. Chalmers, Manchester—Improvements in looms for weaving
1917. J. W. D. Brown, Barrel's Hotel, London-bridge, and G. G. Brown, Deptford Dockyard—Improvements in single lanterns
1918. A. Hodgkinson, Springfield Bleach Works, Belfast—Improvements in bleaching scouring, and cleansing plain and embroidered fabrics
1919. S. Lilley, Birmingham—Improvements in the manufacture of ships' iron work, a part of which improvements is applicable to the manufacture of other articles in iron
1920. P. P. Hoffmann—An improved compound to be used for waterproofing fabrics, paper, leather, or other materials
1921. L. A. Joyeux, Marseilles—Improvements in obtaining motive power

Dated August 18.

1922. T. C. Richardson, Drury-lane—The process for the procuring and manufacturing the sulpho-saccharate of simarubine
1923. T. Scott, Barnhill Workhouse, Glasgow—Improvements in cooking
1924. W. Tytherleigh, Birmingham—A new or improved manufacture of rollers or cylinders for printing fabrics
1925. W. E. Newton, Chancery-lane—Improved machinery for cutting and finishing metal screws. (Communication)
1926. W. C. Cambridge, Bristol—Improvements in the construction of portable railways
1927. W. E. Newton, Chancery-lane—Improved machinery for forging or working iron and other metals. (Communication)
1928. J. Stopperton, Isle of Man—Improvements in propelling vessels
1929. R. A. Brooman, Fleet-street—Improvements in stopping or retarding railway carriages and trains, and in preventing carriages from running off the rails. (Communication)
1930. A. P. How, Mark-lane—Improvements in pumps
1931. C. M. Chouillon, Paris—Improvements in thinning or shaving tawed, tanned, or dressed skins

Dated August 19.

1932. J. Leach, W. Turner, and J. Tempest, Rochdale—Improvements in rollers, applicable to condensing and all other kinds of engines, for carding wool, cotton, and other fibrous materials
1933. H. F. Osman, Essex-street, Strand—An improved electric clock. (Communication)
1934. P. Noyer, Gerrard-street, Soho—Winding up fusee watches and pocket chronometers and setting the hands without key
1935. E. Sutton, Regent-street—An improved construction of stereoscope
1936. H. Burden, Troy, New York—Improvements in machinery or apparatus for manufacturing shoes for horses, mules, and other animals
1937. R. Jobson, Wordsley, Stafford—Improvements in apparatus for pouring iron or other metal into moulds
1938. H. Bessemer, Queen-street-place, New Cannon-street—Improvements in the manufacture of iron and steel
1939. J. Brouard and J. Hubert, South-street, Finsbury—Improvements in reefing the sails of ships or vessels
1940. J. Apperly, Dudbridge, near Stroud—Improved machinery for carding wool, or other similar fibrous substances
1941. W. E. Newton, Chancery-lane—An improvement in valves for steam-engines. (Communication)
1942. A. C. V. de Doggenfeld, Trinity-square, Brixton—Improved glass ornaments for ornamenting gardens, summer houses, dinner and other tables, and for other ornamental or decorative purposes

Dated August 20.

1943. J. H. Johnson, Lincoln's-inn-fields—Improvements in steam-engines. (Communication from M. Duvoir, Liancourt, France)
1944. J. H. Johnson, Lincoln's-inn-fields—Improvements in roller fulling mills. (Communication from T. Wiede, Chemnitz, and E. Pressprich, Grossenhain, Saxony)
1945. T. Sagar, Burnley, and C. Turner, Lancaster—Improvements in power looms for weaving
1946. C. Clark, Somerset-terrace, Albion-road, Stoke Newington—Improvements in combining and arranging looking glasses for toilet purposes
1947. W. Gossage, Widnes, Lancaster—Improvements in obtaining sulphur and metals from certain ores and other compounds of metals
1948. J. Laleman, Lille, France—Improved machinery for combing flax and other similar fibrous materials. (Communication)
1949. W. Stones, Greenhithe, Kent—Improved machinery for damping sheets of paper intended to be printed upon, so as to render the usual operation of wetting unnecessary
1950. J. Maudslay, Lambeth—Improvements in steam-engines, especially applicable to screw propulsion

Dated August 21.

1951. J. Hacking, Clitheroe, and W. Wheeler, Lancaster—Improvements in the mode or method of winding, warping, sizing, and beaming cotton, woollen, linen, or other yarns or threads, and in the machinery or apparatus employed therein
1952. J. Crossley and J. Bolton, Halifax—Improvements in apparatus or means employed in the printing of yarns for carpets and other fabrics
1953. W. Akroyd and J. Thompson, Halifax—The manufacture of carpets or other fabrics
1955. T. York, Wolverhampton—A new or improved safety valve and low-water indicator for steam-boilers
1956. R. Kenton, Birmingham—A new or improved manufacture of fishing reels
1957. W. E. Newton, Chancery-lane—Improvements in pumps for raising water. (Communication from M. Poujade, Lyon)
1958. G. J. Farmer, Birmingham—Improvements in machinery to be used in the manufacture of chain links, buckles, buckle slides, rings, and other similar articles

Dated August 22.

1959. T. J. Chipp and R. Bitmead, Soho—Improved apparatus for drilling and boring
1960. W. Patten, Old Fish-street, Doctors'-commons—An improvement in apparatus for supplying water to the basins of water-closets and other vessels
1961. C. D. Garrdissal, Bedford-street, Strand—A new or improved rotary engine. (Communication)
1962. W. E. Newton, Chancery-lane—Improved machinery for cutting chenille. (Communication from Messieurs Cadinot and Chenevieure, Elbeuf, France)
1963. S. Jay and G. Smith, Regent-street—Improvements in ornamenting or trimming articles of outer attire, such as dresses, mantles, bonnets, and the like

Dated August 23.

1964. F. A. Gatty, Accrington—Improvements in dyeing
1965. P. Benoist, Rue de Lancry, Paris—An improvement in the construction of stereoscopes
1966. E. Hallen, Cornwall-road, Lambeth—Improved means for washing wool
1967. J. H. Johnson, Lincoln's-inn-fields—Improvements in stocking looms. (Communication from J. N. Brocard, Troyes, France)
1968. J. H. Johnson, Lincoln's-inn-fields—Improvements in casting metals. (Communication from Jackson Brothers, Petin, Gaudet and Co., Rive de Gier, France)
1969. W. Racster, Francis-street, Woolwich—Improvements in apparatus for regulating the supply of gas
1970. E. Sterlingue, Paris—Improvements in preparing for tanning, and in tanning hides and skins
1971. A. Moses, Cannon-street-road East—Improved machinery for propelling vessels on water
1972. G. J. Farmer, Birmingham—Improvements in hardening iron and steel
1973. J. Wadsworth, Hazelgrove, near Stockport—Improvements in the ventilation of mines, and in removing noxious gases or vapours from places in which they accumulate or are generated, and in machinery or apparatus applicable to and to be used for such purposes
1974. S. Stocks, Collins Green, Warrington—Improvements in reaping machines

Dated August 25.

1975. H. Dickie, Girvan, Ayr—Improvements in machinery or apparatus for cutting or shaping wood or other substances
1976. M. A. F. Mennons, Rue Napoléon Montmartre, France—A new composition applicable to the coating or covering of metallic and non-metallic surfaces.
1977. W. Webb, Wilson-street—An improvement in reclining chairs
1978. P. P. C. Barrat and J. B. Barrat, Paris—Improvements in steam digging apparatus, suitable for draining and excavating purposes, parts of which are applicable to reaping
1979. T. Marples, Derby—Improvements in corn mills
1980. W. F. Plummer, St. Mary's Overy Wharf, Southwark—Improved apparatus applicable to the grinding of grain and other substances
1981. H. Bessemer, Queen-street-place, New Cannon-street—Improvements in the manufacture of iron and steel

Dated August 26.

1983. J. Perry, Great Portland-street—Improvements in photography
1984. W. H. Perkin, King David Fort, Saint George-in-the-East—Producing a new colouring matter for dyeing with a lilac or purple colour stuffs of silk, cotton, wool, or other materials
1985. W. F. Bush, and W. Hewitt, Bristol—Improvements in machinery or apparatus for grinding grain
1986. J. H. and T. Horton, Birmingham—An improvement or improvements in the manufacture of paper, paste-board, and pulp
1987. C. Carey, Parade, Harleyford-road, Vauxhall—Improvements in shower baths
1988. E. A. Cowper, Great George-street, Westminster—An improvement in the manufacture of candles

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1989. James Earl of Caithness, Barrogill Castle, Caithness—Improvements in cutting or shaping stone and other substances
1990. E. Simpson, Preston, Lancaster—An improved safety cage for mines and pits, or apparatus to be fitted to cages to prevent accidents from the falling thereof
1991. R. W. Vivian, Camborne, Cornwall—Economising the consumption of fuel

Dated August 27.

1994. L. Horrie, Keighley, York, and J. Schofield, Rochdale—Improvements in the mode or method of extracting oil and grease separately from suds used in washing flannel and other woollen goods, for distilling the said grease or other fatty matters, and in the apparatus employed therein
1996. J. Moore, and W. Moore, Aston, near Birmingham—A new or improved tap or stop cock
1997. T. Lees, Stockport, Chester—Improvements in lubricating parts of steam-engines, and in apparatus and machinery to be applied for that purpose
1998. S. Roberts, Hull—Improvements in regulating the supply of steam to engines working screw or submerged propellers, and in regulating or relieving the pressure of steam on slide valves
1999. A. V. Newton, Chancery-lane—An improvement in projectiles for cannon. (Communication)
2000. A. V. Newton, Chancery-lane—Improved machinery for combing fibrous substances. (Communication)
2001. I. Colbeck, Batley, York—Immprovements in machinery for tearing rags, adapted particularly for shoddy or artificial wool
2002. W. Green, G. Holloway, and T. Grubb, Kidderminster—Improvements in the manufacture of rugs

Dated August 28.

2008. C. D. Gardissal, Bedford-street, Strand—A mode of treating and preparing sea-weeds or marine plants for manure. (Communication)
2004. C. D. Gardissal, Bedford-street, Strand—A new manufacture of artificial fuel. (Communication)
2005. R. A. Brooman, Fleet-street—Improvements in shuttles. (Communication)
2006. B. A. Grautoff and C. H. W. Albrecht, Lime-street-square—Improvements in the construction of pressure and vacuum guages. (Communication)
2007. T. Watson, Poland-street—Improved beer-engine, lever, or lifter, and apparatus for fitting the same to counters
2008. C. Heilmann, Milk-street, Cheapside—Improvements in furnaces of steam-boilers
2009. J. B. Feauveau and L. A. Legrand, Brussels—An improved apparatus for the purification and combustion of gas

Dated August 29.

2010. J. Avery, Essex-street, Strand—Improvements in bellows. (Communication from Chardon and Co., Lyons, France)
2012. J. R. Sees, New York, U.S.—Improved apparatus for heating the feed water of steam-boilers
2013. J. Brown, Pendleton—Improvements in swinging hammocks, and in the construction of bedsteads or couches, and in apparatus connected therewith

Dated August 30.

2014. J. Fletcher and W. Fletcher, Salford—Improvements in the construction of weighing cranes or other similar elevating machines
2015. J. H. Johnson, Lincoln's-inn-fields—Improvements in fire-arms. (Communication from J. E. Halsey, New York)
2016. J. Blake and F. Maxwell, Kitchen-street, Liverpool—Improvements in the manufacture of soap. (Communication)
2020. C. Goodyear, Leicester-square—An improvement in combining gutta-percha and asphalte or pitch
2021. H. Conant, Connecticut, U.S.—A new and useful improvement in fire-arms
2022. D. Sutton, Banbury—An improvement in the manufacture of cast-iron cooking kettles and such like hollow ware
2023. J. Gregory, Nelson-square—An improved fish joint or method of connecting rails
2024. M. Bower, R. Peyton, and J. W. Downing, Birmingham—Improvements in metallic bedsteads, couches, and other such like articles

Dated September 1.

2025. G. Hamilton, Blackland Mill, Paisley—Improvements in the treatment or finishing of textile fabrics
2026. M. E. Bowra, Basinghall-street—Improvements in the laying or placing of rails or chairs for railway and other purposes in the shape of beds or springs or elastic sleepers
2027. T. P. Hawkins, Birmingham—A new or improved manufacture of wire chain
2029. R. H. Norris, Stafford-street, Birmingham—Improvements in photography by the use of collodion in a dry condition, and for a means of transferring photographic films
2030. A. V. Newton, Chancery-lane—An improved charger for shot-pouches. (Communication)
2031. E. H. C. Monckton, Chancery-lane—Improvements in blast furnaces for smelting ores
2032. F. Levick, jun., Cwm Celyn and Blaina Iron Works, Monmouth—Improvements in the construction and working of blast furnaces for the smelting or making of iron

Dated September 2.

2034. M. Aron, Rue de l'Echiquier, Paris—An improved leaven
2035. A. Archer, Old Swan, near Liverpool—Improvements in the manufacture or preparing for use founders' charcoal blacking, coal dust, loam, and facing sand
2036. J. Bate, Birmingham—Improvements in folios, clips, or files for holding letters, invoices, and other documents
2037. J. Apperly, Dudbridge, near Stroud—Improvements in the process of preparing cotton, wool, flax, and other fibrous substances for spinning, and in carding and preparing machinery
2038. P. J. Guyet, Paris—An improved method of stopping or retarding railway carriages and trains, and of warming the interior thereof

Dated September 3.

2039. G. C. Thomas, Washington, U.S.—An improved method of making steel. (Communication from H. Vaughan, Providence, Rhode Island)
2040. J. Lamb, Manchester—Improvements in machinery or apparatus for preparing, slubbing, and roving cotton and other fibrous substances
2042. S. Hallen and E. Hallen, Cornwall-road, Lambeth—Improvements in rolling metallic substances
2043. J. Metcalf, Newton Heath, near Manchester—Improvements in the manufacture and treatment of tar oil for dissolving india-rubber, gutta-percha, gums and gum resins, and also in deodorising all fabrics, wood, or any article impregnated with tar oil or the products from coal-tar
2044. L. Cornides, Trafalgar-square—A new method of dressing or preparing hides, skins, intestines, and such like animal substances
2045. S. Ghidiglia and L. Turletti, South-street, Finsbury—An improved buckle
2046. E. P. Spiller, Holborn-hill—Improvements in the construction of chamber lamps
2047. J. Roberts, Upnor, Kent—An improvement in the stoppering or closing of jars, bottles, and other vessels, applicable also to the joining of earthenware and other pipes.
2048. A. J. Mozard, Dufour-place, Golden-square—Improvements in the construction of miners' lamps

Dated September 4.

2050. W. Bishton, Wolverhampton—An improvement or improvements in boats for inland navigation
2051. J. Morrisson and S. Amphlet, Birmingham—A new or improved fastening for belts, bands, and other such like articles
2052. C. J. Dumery, Paris—Improvements in steam-engines
2053. J. T. Hart, Lexington, Kentucky—Improvements in apparatus for modelling statuary from life, and for measuring and copying statuary and other uneven surfaces
2054. E. Leigh and G. P. Leigh, Manchester—Improvements in parts of machinery or apparatus used in preparing and spinning cotton and other fibrous substances
2055. G. A. Lewis, Bristol—Disconnecting and raising screw propellers
2056. E. A. Roy, J. A. Hall, and W. T. Binns, Camden-town—An improved means of insuring draught in smoke flues or chimneys
2057. W. Keates, Liverpool—Improvements in the process of reducing copper to the metallic state from ores and other materials containing copper, and in the furnaces employed therein
2058. G. Anderson, Queen's-road, Dalston—Improvements in the combustion of tar and other similar matters in heating gas retorts, and in the consumption of smoke arising therefrom, and from other fuels used therewith
2059. J. M. Hayes, Southsea—An improvement in the construction of cartridges for fire-arms
2060. W. Moberly, Ravenhead, near St. Helen's, Lancaster—Improvements in the grinding and polishing of curved and rounded surfaces. (Partly a communication)
2061. J. L. Tabberner, Trafalgar-square—Certain improvements in smelting ores
2062. B. O'Neal Stratford, Earl of Aldborough, Stratford-lodge, Wicklow—Improvements in aerial navigation and in the apparatus connected therewith, parts of which are applicable to locomotion generally
2063. R. A. Brooman, Fleet-street—Improvements in the construction of buildings and parts of buildings. (Communication from Messrs. Charpentier, Brothers)

Dated September 5.

2064. J. B. Dancer, Manchester—Improvements in photographic cameras and in the apparatus connected therewith
2065. H. E. C. Monckton, Parthenon Club, Regent-street, and W. Clark, Upper-terrace, Islington—Improvements in machinery or apparatus for tilling or cultivating the soil
2066. J. Johnson, Single-street, Mile-end—Improvements in railway carriages
2067. A. E. Duchateau, Essex-street, Strand—Improvements in stamp presses and stamps used therewith
2068. W. S. Mitchell, Cornhill, and C. M. Gartner, Lower Ashby-street, Northampton-square—Improvements in the construction of watches
2069. R. Reeder, Cincinnati—An improved universal dial and chronometer compass
2070. R. Wilson, Patricroft—Improvements in valves and apparatus connected therewith
2071. T. Burstall, Southall—Improved machinery for manufacturing bricks and tiles from clay alone or mixed with other materials
2072. J. Johnson, Ohio, U.S.—Improvements in photographic plates. (Communication)
2073. C. L. F. Helrigel, Great James-street, Bedford-row—Improvements in lithographic printing presses

Dated September 6.

2075. J. Anelli, Talbot-villas, Paddington—A Crampon to prevent horses slipping in frosty weather
2077. J. Juckes, Dame-street, Islington—Improvements in stoves or fire-places
2078. G. P. Harding, Kingsland—Improvements in the manufacture of hats and other coverings for the head or parts thereof
2079. P. Wright, Dudley—An improvement in the manufacture of anvils
2080. A. V. Newton, Chancery-lane—Improved machinery for cutting round files. (Communication)
2081. C. L. Lapito, Faubourg Poissonier, Paris—A machine for manufacturing of mortar and concrete
2082. W. Wilkens, Baltimore—Revolving cylinder battery or cannon, and apparatus connected therewith. (Communication)
2088. P. A. le Comte de Fontainemoreau, South-street, Finsbury—Improvements in making artificial stone for statues and ornamenting purposes. (Communication)
2084. H. E. Trottier, South-street, Finsbury—An improved portable bath
2085. P. R. Hodge, Albion Grove, Islington—Improvements in grinding wheat and other farinaceous grains, and in the treatment of the products therefrom.

Dated September 8.

2086. T. Craig, Glasgow—Improvements in ruling paper and other materials
2087. F. Estivant, Essex-street, Strand—Improvements in casting metal tubes.
2088. A. G. Chalus, Essex-street, Strand—Improvements in stopping bottles and other vessels
2089. J. Fowler, jun., Havering, Essex—Improvements in machinery or apparatus for ploughing and tilling land by steam
2090. A. Dalton, Chester—Improvements in smelting ironstones and ores, and in furnaces used for that purpose
2091. R. Bamford, Preston—Improvements in looms for weaving
2093. F. M. Herring, Basinghall-street—Improvements in applying magnetic action to combs and brushes
2094. T. Restell, New Kent-road—Improvements in breech-loading fire-arms and ordnance
2095 W. Petrie, Woolwich—Improvements in the manufacture of sulphuric acid and the apparatus employed therein, parts of which improvements are applicable to the manufacture of nitric, hydrochloric, and other acids
2096. A. V. Newton, Chancery-lane—Improved machinery for cutting india-rubber and other substances into threads or narrow strips. (Communication from H. Davenport, New York)

Dated September 9.

2098. W. Pidding, Trinity-terrace, Southwark—Improvements in the preparation and manufacture of certain piled, corded, or other fabrics
2100. W. Gossage, Widnes—Improvements in the manufacture of certain kinds of soap
2102. C. Brook, jun., Meltham Mills, near Huddersfield—An improvement in polishing or finishing yarns, threads, and woven fabrics

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PATENTS APPLIED FOR WITH COMPLETE SPECIFICATION.

2011. E. Poitiers, Malden-terrace, Haverstock-hill—The application of a new material or materials for the manufacture of brooms and brushes in general and for other purposes, and for improvements in the manufacture of street scavengers' and other brooms and brushes.—August 29.
2103. G. G. T. Bousfield, Sussex-place, Loughborough-road, Brixton—An improvement in flying or roving frames. (Communication).—September 9.
2131. C. J. Dumery, Paris—Improvements in apparatus for counting, registering, and indicating the distance travelled by vehicles, and the speed and time of travelling.—September 11
2033. L. S. Magnus, Adelaide Chambers, city of London—Improvements in the manufacture of coke. (Communication)—September 1.

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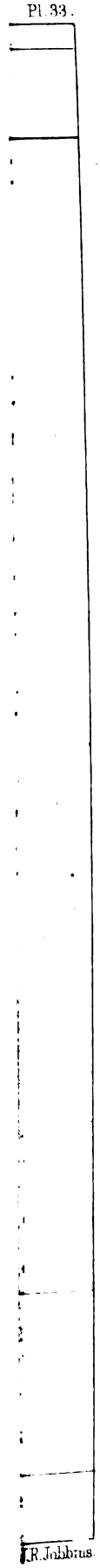

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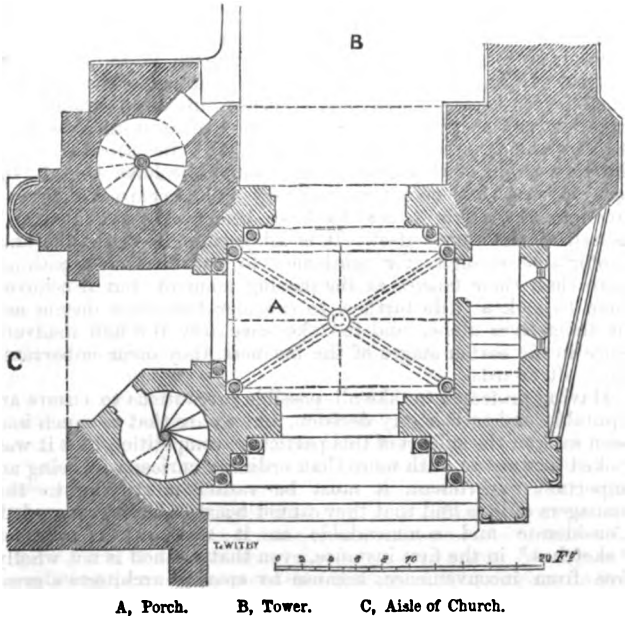
ST. MICHAEL'S CHURCH, CORNHILL.

(With an Engraving, Plate XXXIII.)

Every Londoner will recollect how that, till quite recently, the only portion of St. Michael's Church visible externally was the upper part of the tower, which is allowed to be a noble conception in point of outline, and in detail more consistent with the style of Gothic which the architect emulated than any other production of Sir Christopher Wren. A year or two since the ground which intervened between the Church and Cornhill reverted again to the parish, who then wisely resolved not to repair any more the odd-looking inconvenient buildings thereon, but to throw open the full height of the steeple, and make a suitable entrance from Cornhill in place of the former right of way between the shops. This resolution is now being carried practically into effect; a most elaborate and beautiful porch, of which we have given elevations and a plan, having been commenced from the design of Messrs. G. G. Scott and W. A. Mason. In making this addition, the endeavour has been to design such a work as should sufficiently harmonise with the old tower to prevent a decided incongruity, without being compelled to follow Wren's objectionable ideas of Gothic art.

The new porch will be of large size, and have a deeply-recessed doorway next the street, with a pointed-arched head, the tympanum of which is to be enriched with carving of a scriptural subject. This doorway is of three orders, supported by red granite columns, whose caps, bases, and arch mouldings, will be highly enriched. A gable-moulding spans the doorway and is continued above the open parapet, terminating in a cross. The side elevation preserves the main horizontal lines of the front, and is divided into two heights, the lower one containing the projecting staircase down to a vault, and the upper one containing the window lighting the interior of the porch. The accompanying block plan will explain the general arrangement, and it will be perceived that the interior is to be groined. The circular staircase, to the left of the entrance, leads up to the roofs. The contractors for the general masonry (which is to be wholly of Portland stone) are Messrs. James Browne and Co., of College-hill, and the proposed outlay is about 2500*l.*, including the carving and enrichments, which are to be of the most elaborate kind.



A, Porch. B, Tower. C, Aisle of Church.

In a previous number we referred to the Roman wall discovered in digging for the foundations of this porch. This wall still remains undisturbed.

The restoration of St. Anne's Church, Limehouse, is in active progress. Supscriptions amounting to about 800*l.* have been given: 700*l.* are still required to complete the edifice.

ARCHITECTURAL EXHIBITION.

Now that the period is fast approaching for the re-opening of this exhibition, it behoves the members of the profession, one and all, to exert themselves so as to render the success of the ensuing year as complete as the last. It will be seen from the circular issued by the Committee, that they have not been inactive: their number has been increased—that of the local honorary secretaries nearly doubled—and certain modifications adopted in the regulations to exhibitors, which will doubtless prove advantageous. It may be well to remind such parties of the new rule as to the size of certain pictures, viz.—that "any number of drawings illustrating one design may be included in one frame; but, when several subjects are collected together, such frame or strainer must not, in any case, contain more than *five* superficial feet."

Very much of the interest of this Exhibition must depend on the general co-operation of architects in forwarding illustrations of works in progress under their direction, that country visitors may have an opportunity of examining their similar contributors, and Londoners get an insight into what is doing elsewhere. The department of public buildings, including commercial works, is an especially important one, which we shall be glad to see adequately represented. Again, that useful feature of former collections, "the department for models, manufactures and inventions," is capable of being rendered vastly more serviceable than hitherto, if proprietors of articles are awake to their own interest, and the Committee can set apart sufficient room. We have reason to know that this portion of the undertaking is becoming better appreciated, and that the floor-space in the two rooms set apart is being readily taken at the rate of a guinea a square yard, counter-space at the same, and wall-space at a lower figure. On the facilities thus afforded, and the advantages accruing to builders and decorators especially, by their productions being thus brought prominently forward, there is no necessity for enlarging.

It could hardly be doubted but that so successful an experiment as the weekly lectures in the rooms proved last year, would again be repeated; so that in addition to the names of Messrs. Allom and Scharf, who have lectured before, we see those of Professor Donaldson, Mr. R. W. Billings, the Rev. C. Boutell, and Mr. Owen Jones; to which rumour adds, Professor Willis, and Mr. E. B. Lamb. To the attractiveness of the subjects of the lectures, as well as their intrinsic merit, may be attributed the disposal of so many season tickets last year, which admitted on the above evenings, and by the sale of which it appears as much was realised as from the entire admissions during the previous season.

The days fixed for receiving the "Drawings" and "Materials" intended for exhibition are *limited* to the 1st and 2nd of December; the rooms to be opened to the public on the 17th.

It will probably be well for intending country exhibitors to notify the same to their respective local secretaries;—as an agent in London, to receive and deliver the drawings at the galleries, Mr. Green, of Charles-street, Middlesex Hospital, is suggested, whose experience in the like duty for other societies is in itself a sufficient recommendation.

We have but one word to add to the contributors. Let small plans (in block will often answer the purpose) be appended to their perspective views, to convey a notion of the disposition of the parts. Plans to a large scale are objectionable only in that they occupy room which might perhaps be better filled up.

One word, too, to the Managing Committee. Let kindred subjects, in competition works particularly, be classified as far as possible. If picturesqueness in the general grouping seem wanting, the practical utility of the arrangement will more than counterbalance the loss.

Orders have been issued for the erection of the Presidency College, Calcutta. This building, which will correspond to a great degree with University College, London, is to cost 80,000*l.* The edifice will be a great addition to the architectural beauty of Calcutta. The city has not one single professional architect, and the public buildings are some of them somewhat ludicrous to a professional eye. The college, of very simple design, will be of a large size, as it is to contain two colleges, rooms for 400 resident pupils, theatres, lecture-rooms, and a grand hall for the University Senate.

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NEW GOVERNMENT OFFICES.

THE Commissioners of her Majesty's Works and Public Buildings have issued the particulars of this competition. They are prepared to receive three designs from architects of all countries: the first, to comprise a scheme for the concentration of the principal Government offices on a site lying between Whitehall and the New Palace at Westminster; the other two designs for buildings which her Majesty's Government have determined to erect forthwith as parts of such scheme—one for the department of the Secretary of State for Foreign Affairs, and the other for the Secretary of State for War.

The buildings are to be fireproof, the rooms lofty, and the corridors wide. Every design is to be inscribed with a motto, and delivered (carriage free) between the 1st and 20th (inclusive) of March 1857, at Westminster Hall, where it is intended they shall be publicly exhibited. An envelope, with the same motto on the outside, containing the name and address of the competitor, is to be sent to the First Commissioner of her Majesty's Works and Public Buildings, Whitehall, London. General specifications of the materials proposed to be used in the buildings must accompany the designs.

The *first design* is to show, by a block plan, the best mode of concentrating the principal Government Offices on a site comprised within the space bounded by a red line on a plan accompanying the particulars, including a space to be obtained by the proposed embankment of the River Thames. The design is also to represent any improvements which the author may suggest in the principal approaches to the New Palace at Westminster, as well as in the communications with the Surrey side of the river Thames, especially with reference to the situation of the New Westminster-bridge, the ultimate position of which must be considered in connection with this design.

The design for the block plan must be drawn to a scale of 44 ft. to an inch; and the proposed improvements of the leading thoroughfares, &c., to a scale of 5 feet to one statute mile. The Government Buildings, or any of them now standing on the site, may form a part of the general plan to be submitted by any architect, if he should consider them available for that purpose.

The Government have determined that the buildings for the departments of the Secretary of State for Foreign Affairs, and the Secretary of State for War, shall be erected upon the part of the site tinted yellow on the plans, and that the Foreign Office shall be next the park: architects must therefore design the general plan in accordance with that arrangement.

Architects desiring to send in models with this design will be permitted to do so, provided the models are made to the same scales as the design; but drawings in frames (other than straining frames) and glasses will not be received.

Any alteration in the existing levels of the streets must be shown upon the drawings and models.

Architects must, in addition to the Offices, of which a list of twenty is given, provide for further buildings (to be afterwards appropriated as the Government may determine) to such an extent as may be consistent with proper open spaces and thoroughfares.

The *second design* is to comprise a public office and an official residence for the Secretary of State for Foreign Affairs, to be erected near the site of the present Foreign Office and the St. James's Park.

The drawings tinted in light brown indian-ink are to show a plan of each floor, longitudinal and transverse sections, and elevations (in line only) drawn to a scale of 16 feet to an inch, with the sizes and lengths of the rooms figured thereon. An elevation of one of the principal fronts drawn to a scale of 8 feet to an inch is required; and one perspective view, tinted with light brown indian-ink, may accompany the designs; but models, bird's-eye perspective views, and drawings in frames (other than straining frames) and glasses, will not be received.

The *third design* is for the department for the Secretary of State for War. It is intended to erect the building for the use of this department near or facing Parliament-street. The drawings are to show a plan of each floor, longitudinal and transverse sections, and elevations drawn to a scale of 16 feet to an inch, and an elevation of one of the principal fronts to a scale of 8 feet to an inch is required. The plans and sections are to have the sizes and heights of the rooms figured thereon, and are to be tinted in light brown indian-ink; the elevations are to be in line only.

One perspective view, tinted with light brown indian-ink, may accompany the designs; but models, bird's-eye perspective views, and drawings in frames (other than straining frames) and glasses, will not be received.

Premiums.

	No. 1	No. 2	No. 3
First Premium	£500	£800	£800
Second „	200	500	500
Third „	100	300	300
Fourth „		200	200
Fifth „ }			
Sixth „ }		100 each	100 each.
Seventh „ }			

If the architect to whom a premium may be awarded in respect of designs No. 2 and 3 or either of them, shall be employed to superintend the execution of the work, he will not be entitled to receive such premium, but he will be paid a commission, at the rate of 5 per cent. upon the outlay. Such commission to include all expenses for measuring, superintendence, &c., except the salaries to clerks of works.

The designs in respect to which premiums may be given, are thereupon to become the property of the government.

THE LIVERPOOL FREE LIBRARY COMPETITION.

IT is with unaffected concern that we find ourselves compelled to confess, that what promised to set a beneficial and much-needed example to future competitions, and to correct much, if not all, that is objectionable in the present system, equally oppressive to the profession and injurious to architecture itself, has proved a failure. Of what showed fair in theory, the practical result has turned out to be far from satisfactory. The best part of the for the first time adopted scheme, was the asking for no more than sketches to be sent by way of preliminary trial; therefore all but the sixteen, out of the original one hundred and fifteen competitors, who were admitted to the second trial, were put out of the misery of anxious suspense at once, and relieved from all further labour in vain. So far good: but there is now reason for suspecting that the inspection of the sketches must have been performed very perfunctorily, and without anything like diligent examination, when so many of those which obtained the preference have shown themselves to be either very common-place or impracticable designs. It is, therefore, not at all improbable that several much better ideas, though only sketched out, were through inattention, or else perhaps sheer weariness of examining such a shoal of them, passed over. Else, if all the selected were the very cream of them, what must the others have been? In fact, to make use of a very ordinary and perhaps vulgar expression, the affair seems to have been sadly muddled and messed at the very outset. It is all very well—agreeable and comfortable enough, for gentlemen to consult lazily nothing more than their fancies at the passing moment; but it behoves them to look a little further, to consider that they do not act for themselves alone, and to take care lest through inadvertence in the earlier stages of the business, they incur embarrassment afterwards.

Having professed to take all possible precautions to ensure an equitable and satisfactory decision, and aware that so much had been said on the subject of this particular competition that it was looked forward to with more than ordinary curiosity as being an important experiment, it must be rather mortifying to the managers of it to find that they cannot boast of having succeeded. Considerate and commendable as it was to ask only for "sketches" in the first instance, even that method is not wholly free from inconvenience; because by sparing architects a great deal of hard work, and holding out to them a chance upon comparatively easy terms, it induces numbers to try who else would never think of doing so. The consequence is, so very many sketches are received that it must take some time merely to reconnoitre them all. Fairly to examine and compare them together would be no easy task, even for the experienced—for those who are not familiar with drawings of the kind, almost an impossibility. Much, therefore, as we approve of the "sketch" principle, we must acknowledge that it has a tendency to produce a glut of embryo designs. Never would there have been anything like the same number of competitors for the Free Library, had the

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usual course been pursued. What the Committee ought to have done, after selecting sixteen as appearing to them the most promising, was to consider them afresh and more deliberately; and then return them to their respective authors, with remarks and suggestions. To more than one they might have said: "Have you forgotten the limits as to cost?" Instead of which, they seem to have forgotten the rather important point of cost themselves. A moment's reflection would have convinced them that designs so widely different in regard to the *quantum* of embellishment, could not possibly be brought to tally with the same estimate. Or are we to suppose that sculpture and other enrichment was held to be what could just as well as not be omitted, if it were found that it could not be afforded?

Certain it is that the design with the motto, "Con Amore," to which the first premium was adjudged, cannot be executed in its integrity without going enormously beyond the estimate by which the competitors were at least to be guided, though not, perhaps, tied down to its very letter. The choice of it completely sets aside and nullifies the not least of all important condition in the understood contract between committee and competitors, with very great injustice towards those few who, endeavouring to comply with it, sobered their fancy down to the moderate money-temperature of actual circumstances. In this case, however, the blame of choosing what they must have known could not be executed for the sum named in the instructions, falls upon the competitors themselves, they being for the very first time allowed to act as judges also, each having the power of adding to his own motto, which of course stood for no more than his signature, those of three other designs as the most eligible. Yet although we have heard it previously suggested and strongly advocated by a very talented member of the profession, we have always entertained serious misgivings as to its practical working. Were everyone disposed to sacrifice self to the interest and advancement of his art, and at the same time capable of clearly seeing what would best promote it, the opinions, that is, the carefully-given opinions, of those who had worked out the same problem for themselves, might be relied upon as sufficiently trustworthy. But, alas! for the infirmity of poor human nature. Where his own personal interest is immediately concerned, it is not every-one that will for the sake of art, give his vote to what he really feels to be a very superior design, because if adopted it would throw him several degrees further in the shade; whereas, if he votes for a commonplace design, and it should happen to be the chosen one—as is as likely, perhaps more so, than not—he has, though defeated, the consolation of being able to say: "My own design was, if not better, quite as good." Admitting that it was liberal and so far commendable, to allow the competitors to vote, it does not follow that that ought to have been considered decisive, without further investigation by persons competently qualified to calmly and deliberately canvass the matter among themselves—regarding the votes given in the first instance, and unsupported by any show whatever of reason for them, as no more than recommendations to be attended to, yet not absolutely abided by. In the Liverpool Free Library case, the committee acted well in permitting the competitors themselves to express their opinions, for their (the committee's) so far instruction and guidance; but they were wrong in suffering themselves to be dragged into a ditch, from which they have now to extricate themselves as well as they can, and if they can to come out as unsoiled and unsmirched as when they tumbled into it.

If we may believe what has been said of it, the design which obtained the largest number of votes cannot possibly be executed for less than three times the sum to which, in the instructions issued to them, the competitors were restricted: more probably than not, there may be a good deal of exaggeration as to the excess beyond the estimate stipulated for. Neither is that design, it seems, the only one which fearlessly leaped over the more than five-bar-gate barrier of expense, translating pence into pounds. Therefore, those who, endeavouring to comply with the terms of the programme as to cost, abstained from expletive ornament, paid for their honesty. In fact, 20,000*l.* was barely sufficient, considering what was to be its size and the accommodation to be provided, for more than a plain structure, if it were also to be a substantial stone one. Nevertheless, more than one of the competitors evidently paid no attention to the condition of cost, presuming, no doubt, that it would be greatly relaxed in favour of an approved design. Nor is it to be denied, that a good deal of relaxing or laxity as to the matter of cost has been shown in several instances, wherefore it is the less to be wondered at if it is now little regarded. Yet such laxity is itself one of those evils, and we may say hardships, in competition that require to be corrected. If liberality be a virtue, so also is justice and good faith. A private employer may go to any extent of expenditure beyond what he first limited his architect to, without injury to anyone: not so those who, after inviting architects to send in designs with a fixed ultimatum as to estimate, exceed it, not by a mere three or five per cent., but allow themselves to be drawn in to exceed it to the extent of cent. per cent., if not even more. Of such liberality what is the consequence? The estimate is looked upon as possessing the convenient quality of elasticity in a most wonderful degree. Those who do not give it credit for such quality, but suppose that they might just as well attempt to stretch out a poker to double its original length, as what is made to appear, in invitations to architects, the very *ne plus ultra* of what will be granted them as the pecuniary means of realising their ideas, cheat themselves by their own honesty in endeavouring to keep within decent bounds as to estimate.

What strikes us as no small inconsistency, is that the committee should have had sufficient confidence in their own judgment to undertake to decide for themselves which were the sixteen best out of so many as a hundred and fifteen sketches or unfinished designs, yet leave the ultimate decision entirely to the re-admitted competitors, without claiming for themselves even so much as any further voice in the matter. Without being particularly uncharitable, we are now at liberty to suspect that bewildered by such a variety of first designs, they inadvertently overlooked and excluded some of the better ones, and *vice versâ*, admitted some that were not the very cream of the entire collection. We ourselves happen to know of one set of the sketches sent in, which we considered so admirable that we were quite staggered on learning afterwards that it was among the excluded. Our very natural conclusion, therefore, was that if a design of such merit was not up to the mark, all those which were so selected for the final competition must be of very superior quality indeed; and so far some satisfaction was mingled with surprise. Astonishment *minus* satisfaction is now felt by us on finding that so far from showing talent of any kind, one or two of the re-admitted designs are very common-place affairs; and even of the better ones, very few are unexceptionable in regard to their plans. Out of the whole sixteen, there are scarcely six that have not more or less violated the instructions as to the required accommodation, and the keeping the library department quite distinct from that of the museum. That injunction is disregarded even in the design to which the first premium has been awarded; and the design which obtained the other turns out to be "prigged," as the schoolboys would say, from the Hôtel de Ville at Paris! —a compliment to our neighbours, but not very creditable to ourselves.

The committee fell into a great error in not strictly prohibiting colour, and all those artifices and allurements of the pencil which serve only to lead the judgment astray. And here we may observe, the instructions to the competitors for the new Government Offices err in the opposite extreme, by forbidding even shadow in the elevations, notwithstanding that it is absolutely necessary to enable any one to judge of artistic effect as regards light and shade, upon which so much depends. Colouring, on the contrary, is objectionable as being apt, if well-executed, to divert attention from what has alone to be considered, and by captivating the eye to blind or mislead the judgment; for what may be exceedingly poor and unsatisfactory as a design, may be rendered unduly attractive by means of more adroit and ingenious than ingenuous pictorial treatment. For the same reason, all such pictorial garnish as groups of figures should be strictly prohibited in competition drawings,—no more than a single one, just to serve as a scale, and fairly drawn to scale, should be allowed; neither should any such merely mechanical garnish as ornamental borders be allowed. If the drawings be exhibited to the public, whether before or after the decision has taken place, the showiest ones are sure to obtain the greatest share of admiration and attention. Pictorial merit speaks to almost every eye, and does so at once; whereas it requires not only some acquaintance with architecture, but a rather careful examination of the several drawings that compose a design, to judge of its merits as such. Consequently the competitors are not fairly matched; for those who make no pretension to pictorial bravery and bravura, fight at a considerable disadvantage. We should be ashamed of saying so much that ought to be self-evident to every one, were it not

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that it does not seem to be understood even by those who are entrusted with the management of an architectural competition. The Liverpool committee have, perhaps, by this time found out their mistake, in allowing designs to be coloured *ad captandum*. As far as we have the means of judging, matters are at the present moment in that state which is called "at sixes and sevens." How the competition will terminate we do not presume even to guess, therefore must be content to await the issue.

TELEGRAPHIC COMMUNICATION WITH AMERICA.

ATTENTION has been drawn to telegraphic communication between this country and America, by a public demonstration occasioned by the visit of Professor Morse to this country. The three telegraph companies in London took that opportunity of paying honour to the man who has done so much for the establishment of electric telegraphs in the United States, and whose instruments have, in consequence of their simplicity, been adopted throughout the continent of Europe.

The dinner given to Professor Morse on the 9th ult. was an interesting event when viewed merely as the first public recognition of the value of telegraphic inventions: it derived additional interest from the circumstance that many of his entertainers were competitors in the same field; and it is of special value at the present time, as a testimony from such a body of men of the importance and practicability of the electric telegraph to America. That great undertaking has extended fifteen hundred miles of its way; the cable in connection with New York being now at the most eastern point of Newfoundland, and the whole of it is said to be completed and to be only waiting for favourable opportunity to be joined to the western coast of Ireland.

The mechanical difficulty of laying down a thick iron-wire cable in the depths of the Atlantic will not, it is calculated, be greater than that encountered in crossing the Mediterranean; whilst the experience gained in attempting to lay down the Mediterranean cable will be of great service in suggesting improved arrangements, and in pointing out the dangers to be avoided. Even should disaster attend the undertaking by the fracture of the cable, or by its abandonment at the bottom of the sea during a storm, the enterprise we may feel assured will not be given up. The plan at present adopted is attended with unnecessary difficulty, as the cable consists of several copper wires coated with gutta-percha, enclosed by a rope of thick galvanised iron-wire. The great rigidity of such a cable is a serious obstacle in paying it out from the hold of a ship, and the additional strength becomes in consequence a source of weakness. Should it fail, the single thick wire which was recommended as more suitable for the purpose might then be resorted to, and with such a comparatively pliable and much lighter wire the difficulty might be readily surmounted. In one way or another there seems no doubt that, ere long, a telegraph will be laid across the Atlantic. But will such a wire be able to transmit telegraph signals? That is the question now agitating the telegraphic world, and which throws more doubt on the project than the practicability of establishing an insulated metallic connection under the sea.

That a current of electricity from a voltaic battery can be transmitted by a thin copper wire to a distance equal to the space that separates Newfoundland from Ireland, has been proved by direct experiment on the telegraph wires of the United States. But that proof is not conclusive in the case of submarine wires, which exert peculiar influence in detaining the electricity, and thus cause confusion in the signals. This effect was first observed on the submarine wires to Holland and Belgium, and produced much annoyance. It was found that the telegraph instruments by which the signals are recorded on paper, would not give distinctive indications through the submarine wires. This was especially the case in those telegraphs that recorded the signals by electro-chemical decomposition, for the marking-styles made a continuous line on the paper instead of ceasing to mark as soon as the contact with the battery was broken. The needle-telegraph, however, was not sensibly affected by the detention of the electricity, for the continual reversing of the current, in deflecting the needles to the right hand and to the left, cleared the wire of the residual charge. The same principle was soon applied to the recording instruments, and with perfect success. After each signal the electric current was reversed, and by that means the electricity in the wire was discharged and another signal could then be sent. This plan, though it answered as far as from London to the Hague, in removing the obstruction caused by the retention of electricity in the wire, may not be effectual through a submarine wire two thousand miles in length; and so long as there is any uncertainty about the matter, doubting philosophers will be found to show by profound calculations that the transmission of signals across the Atlantic is impossible. Professor Thomson has thus come into the field to throw cold water on American telegraph enterprise. Founding his calculations on assumed laws of resistance to the passage of electric currents and of the influence of induction, he endeavours to prove that each signal would be so long in traversing the submarine wire to Newfoundland, that for practical purposes the telegraph must be a failure unless the wire and the coating of gutta-percha be of a thickness which it would be impracticable to attain.

On the other hand, experimentalists oppose to these calculations—which rest on assumed and uncertain data—the fact, that currents of electricity have been transmitted through two thousand miles of wire laid underground; which presents a similar obstruction to the passage of electricity as wire immersed in water. The experiment has been made by joining together at each end the alternate wires in a long subterranean telegraphic communication, so that the electric current transmitted from one instrument in London, after traversing the wires to the distant station and back again several times, indicated the signal on another instrument also in London. This experiment was made in the presence of Professor Morse, at the Magnetic Telegraph Office, on the morning of the day on which he was publicly entertained. The wire was copper, of the usual thickness, and the signals were sent and received with rapidity equal to the usual rate of transmitting messages through a single wire. This experiment appears at first sight to be conclusive as regards the practicability of transmitting telegraph signals to America, if a properly insulated wire be extended across the Atlantic. But facts, as well as theories, sometimes mislead into error, and that experiment must, we fear, be regarded as fallacious. Similar experiments had previously been made through wires of fifteen hundred miles by Professor Faraday, and through eight hundred miles by Professor Wheatstone, with less satisfactory results. The latter found that the detention of the electricity occurred *in the middle of the circuit*, whilst at the two poles of the battery the transmission was instantaneous. At the two extremities of the wire, therefore, the telegraph instruments would act without retardation; but if the receiving instrument were placed in the middle, the action would be impeded. Even on a much shorter circuit than the one experimented on by Professor Wheatstone, the same effect is experienced. When, for instance, an electro-chemical recording instrument was tried between London and Birmingham, working through underground wires, the detention of the electricity prevented any distinct marks from being made on paper when the receiving instrument was at Birmingham, and the transmitting one in London. But when the wires were joined together at Birmingham, and the receiving and transmitting instruments were both in London, the marks were distinctly recorded, and gave no trace of detention, though the electricity passed through the same length of wire in each experiment. Now, in practice, the receiving instruments are always in the middle of the circuit, where the greatest detention of electricity occurs; therefore the results of experiments made with both the instruments near the source of electricity, afford no correct indication of what would be the effect on telegraph instruments in actual operation. In the accounts that have been hitherto given of the experiments in the presence of Professor Morse, there is no mention of any special provision for removing the obstruction to the passage of electric signals through submarine wires. It is possible that some contrivance may have been adopted, the successful operation of which made the Professor express with great confidence that no further doubt remained of the practicability of transmitting the signals at a speed commercially available; but, so far as appears, the experiment was simply a repetition, through two thousand miles of underground wire, of experiments before made through similar wire of shorter length; and, if so, they avail but little in proving that signals could be transmitted to Newfoundland. The question, in that case, remains just where it stood; and though the demonstration of the many practical men assembled to do honour to the Professor, in favour of the telegraph to America, is calculated to give additional stimulus to the undertaking, the practicability of transmitting signals with sufficient

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rapidity through the wires when they are laid down, may yet be disputed.

Supposing, however, it should be found that the calculating theorists are right, and that the experimentalists and practical men are wrong, it would not necessarily follow that the project must fail. Should the difficulty present itself, there is good ground for hope that there will also be discovered the means of overcoming it, as was the case with the submarine telegraph to the Hague. Other and more formidable difficulties, which were pronounced impossibilities, have been surmounted in the progress of the electric telegraph; and when the inventive faculties of the scientific and practical men of England and America are brought to bear in effecting one object, it must be next to impossible if it be not accomplished.

One plan, indeed, suggests itself which, if all others fail, would be effectual, and would remove the difficulty from the domain of science into that of practical mechanics. It is within the range of possibility to conduct the communication with America on the same system as that of long telegraphic lines on land. At distances about four hundred miles apart there are stations to which the messages are first transmitted, and thence they are forwarded to the next station, till the proposed destination is attained. In the telegraph from Calcutta to Bombay, a distance of sixteen hundred miles, there are three intermediate stations, at which the messages from the two extreme points are received and forwarded. These relays, as they are called, are usually worked by clerks, who receive and transmit the messages; but it would not be difficult to establish automatically-worked relays, which would transmit the signals from station to station without any manipulation. It may seem a startling proposition to establish such a system of relays across the Atlantic, but the thing is not impossible. Whether the voltaic batteries and accompanying apparatus should be sunk to the bottom, or floated a few fathoms below the surface,—in what manner the indicating buoys should be moored, and other points necessary for effecting such a project, it is useless now to consider. It will be time enough to take them into consideration should the necessity arise for such intermediate steps to complete the communication with America. We entertain little doubt that a direct transmission of messages through the submarine wire will be accomplished; but should that not be practicable, there would still be no reason to despair, since by the means we have indicated messages from London to New York would be flashed along the wires with as much rapidity as if there were no break in the circuit.

FRANCIS WHISHAW, M. Inst. C.E.

Mr. Francis Whishaw, we regret to state, died on Sunday evening, the 5th October. It appeared from the evidence of the inquest that he left his residence on Sunday evening to attend a place of divine worship in Kentish-town, and he was never heard of more, until his deplorable end was made known to his disconsolate relatives. The same night, it seemed, shortly before midnight, the police-constable on duty in the vicinity, observed him in the street, and his attention was further attracted by observing him suddenly stagger and fall to the ground. The constable promptly proceeded to his assistance, when he discovered him in a partially unconscious state, with several marks of violence about his face, and his clothes very dirty, as if he had been falling about. The officer immediately assisted the sufferer to the house of Mr. Allen, a medical practitioner in the neighbourhood, who prescribed for him, and did all that the case appeared to demand. After that he was removed to the workhouse infirmary, where he gradually sank, and expired soon after his admission. On the road to Mr. Allen's the deceased was enabled feebly to tell the policeman that he had left home the same evening to attend divine service at Kentish-town, and that going out during the course of the service after leaving the church his senses seemed to leave him, and he knew nothing further until he found himself wandering on Primrose-hill. He had experienced a like sensation on previous occasions, as he had stated to friends. A supposition might have been raised that the deceased had been hocussed for the purpose of robbery, but such was clearly proved not to have been the case, as about his person was discovered 30*l.* in loose cash, besides a valuable gold watch, rings, &c. From the statement of the deceased's son, it further appeared that his father had lately returned from Boulogne, and at times he complained of pains in the head. Mr. Filliter, surgeon, who performed the post mortem examination, proved the immediate cause of death to be an attack of natural apoplexy.

Mr. Whishaw was born in 1804, and was a member of an ancient and highly respectable English family. After a liberal preliminary education, he was articled as a civil engineer, and acquired a good practice. He took an active part in what is now called the early period of the railway system, but which, so far from being its infancy, was that of its advanced progress. Mr. Whishaw was, we believe, employed on the Blackwall Railway. In connection with this branch of engineering, he published a book called the 'Railways of Great Britain and Ireland,' which, although of old date, is still a standard professional work. He projected, and was engaged in, various metropolitan improvements, including the Holborn-bridge improvement, but he left civil for mechanical engineering, being of a highly inventive turn of mind. Telegraphy was an early subject of his exertions, and he applied himself to the hydraulic telegraph, the practicability of which he demonstrated, and to which he was always attached, but the success of the electric telegraph threw his favourite system into the shade. He, nevertheless, made many useful inventions now in successful operation, and laboriously worked out the plan of telegraph codes and signals, and greatly contributed to the improvement and development of the system at home and abroad. Among other inventions for communicating sound are the telekouphonon, and improvements in speaking-tubes, from which he derived a small revenue. On the extension of the Electric Telegraph Company he was for a short time the superintendent, and organised the administration. On his retirement he received a testimonial from the officers of the company. He devoted much time to the establishment of the electric telegraph in India, and examined for that purpose the telegraph works of England, France, and Prussia; and during the chairmanship of Mr. Shepherd, laid before the East India Company a report, in conjunction with Mr. Hyde Clarke, which had the effect of settling the question, though the organisation of the system was entrusted to other hands. Quite lately he received from the Company a small sum for his expenses out of pocket, which has been the only reward or acknowledgment of himself or of Mr. Clarke, though, we believe, these claims were advocated by the liberality of Dr. O'Shaughnessy, Superintendent of the Indian telegraphs, who has so successfully carried that great work into effect.

It was in connection with the Society of Arts that Mr. Whishaw's public services were best known. Having accepted the secretaryship of that Society when it was at a very low ebb, he laid the basis for its present prosperity, and gave the example of special exhibitions; under his liberal and energetic management, the conversaziones became occasions of *réunion* for the leading professors of science and art. It was while at the society Mr. Whishaw became the means of introducing gutta-percha, and at a later date was for a short time connected with the Gutta-percha Company. His desire to promote the industrial arts led him to devise the plan for the Exhibition of all Nations, in which he received the countenance and co-operation of his Royal Highness Prince Albert, Mr. Robert Stephenson, and others, but in the prosperity of which he found himself, by an intrigue, deprived of all employment and rightful acknowledgment. The committee was first held at the Society of Arts, and afterwards in Gray's-inn. Mr. Thomas Winkworth, the political economist, was the author of the plan of extending the Exhibition to all nations. Mr. Robert Stephenson liberally contributed to the funds, and may be considered virtually as the mainstay of the scheme of the Exhibition.

Mr. Whishaw was solely employed as a local commissioner for a short time in the beginning, and received a small pecuniary grant at the close, and for a while was employed in the Ethnological Department of the Sydenham Palace. In connection with the Great Exhibition, he published a series of well-written descriptions of the Mechanical department in the *Illustrated London News*. He likewise published two or three small pamphlets on his claim. The vexation he felt from the treatment to which he was exposed, and some very heavy pecuniary losses, seriously undermined his health for the last few years of his life, and reduced him to that weak state which has had so melancholy a termination. Much of his time was spent in the condition of an invalid, but at intervals he pursued his labour, being of a most active and energetic mind even when bodily weak. He was lately employed in promoting a museum of patent inventions, which, under the patronage of his friend, Sir John Romilly, the Master of the Rolls, he hoped would have allowed him, even in his inferior state of health, to be of service to the public. One of the last of his inventions is an electric lock, as a means of security for bankers and merchants, and for public institutions, and the object of which he had fully accomplished. A notion of Mr. Whishaw's, now in common use, was the stationery cabinet and writing-desk, sold by the stationers, for which he had a small reward.

The very fortnight before his death, our contemporary, the *Building News*, had taken up the subject of his claims, and advocated a public testimonial or some public reward. Although he is dead, it is to be hoped this will not be altogether forgotten. His wife he unfortunately survived, but he leaves a son and daughters. The son, Mr. John C. Whishaw, is a distinguished student of University College, London; as he is passing through his medical career, a suitable opportunity is offered on his passing his medical examination, for the East India Company to bestow their patronage on him. For the younger members of the family it is to be desired that Lord Palmerston will be induced to afford some provision from the civil list. Of the services of Mr. Whishaw himself some memorial could suitably be erected by the members of the

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engineering profession, the telegraph service, the employees of the Great Exhibition, and the Crystal Palace.

Mr. Whishaw was an old member of the Institution of Civil Engineers, of the Society of Arts, and of other societies. His literary contributions to scientific publications are numerous; but his most valuable writings consist of a series of note books, particularly well-digested, for which no place so suitable as the library of the Institution of Civil Engineers can be found, if the affection of his children will allow them to forego their own claims on the custody of any relic of his.

As a civil and mechanical engineer Francis Whishaw was a man of sound attainments and great acquirements, of a highly original and suggestive train of mind, fostered by careful study and experiment, and tempered by sound judgment. There was no subject he took up practically that he did not make himself acquainted with in its widest scientific relations, closely investigating the working of each detail. If he has not left a great name in some individual invention, that has been matter of accident, from causes beyond his control, for had not Cooke, Wheatstone, and Morse, perfected the electric telegraph, he would have established the hydraulic system. Wheatstone was exposed to a like hazard in the campaign of invention, for his earliest labours were given to the acoustic telegraph, the properties of which have capabilities even still desirable; but finding others engaged in the electric telegraph he applied himself to it, and became the colleague and co-patentee of Cooke. Whishaw still adhered to the hydraulic telegraph, and on the success of the electric telegraph his labours became merged and were secondary to that system; and thus the hard work of years brought him no reputation, although they have been of great public service.

In personal character Francis Whishaw was esteemed for great parts and probity, but his integrity was so unflinching that it earned him many enemies. Independent in his bearing, confident in his integrity, he was a fierce foe to quackery in science and quacks in morals; and as this was marked by some asperity of character, the quacks at length got the better of him. Ousted by intrigues or overcome by toadies and lickspittles, it was easy to represent that Whishaw was uncertain in his temper, unstable in his disposition, and at length that he was an impracticable man; though he was undoubtedly a good servant to those who employed him, a good master to those under him, and a good colleague to those who acted with him. The Great Exhibition clique were, however, too much for him; they were closely banded for their own personal interests, and as it suited them to have Prince Albert for an originator and inventor, instead of Francis Whishaw, Whishaw was systematically put down, and it was even a dangerous thing to speak of him. Some sense of justice and some emotions of generosity, now that he no longer lives to take his rightful place, may, perhaps, allow his services to be commemorated, and his children to share in the fruits of those labours from which others are reaping a rich reward.

REVIEWS

Details of Gothic Architecture. By J. K. Colling, Architect. 2 vols. 4to Royal, 180 Plates. D. Bogue: London.

During the publication of this work, we have repeatedly and with some earnestness called the attention of our architectural readers to its value; it is now finished, and upon looking through the mass of information it contains for study and reference, we are struck with the general utility of the subject matter, as well as at the judgment evinced in the selection. The plates are classified, and range from the Norman to the Perpendicular styles; of course the older work is more scant, but there is a good display of excellent Early English, filling more than fifty plates. The Decorated is also a very prominent feature, occupying some sixty plates, whilst the Perpendicular embraces above fifty. To these may be added a choice selection of metal-work; the whole really forming a pictorial glossary that cannot fail to prove of most essential value to refresh the memory of the student, and awaken suggestive ideas as to the treatment of future labours. Mr. Colling, in a very modest preface, states that:—

"To the architectural student, who is earnestly seeking to gain a knowledge of the principles which guided the master masons of the Middle Ages in the erection and development of their glorious buildings, nothing can be more acceptable or of greater service to him than representing in detail their mode of forming and setting out the smallest matters connected with their works, for it is only by studying in this manner that he can hope ever to arrive at a thorough knowledge of Gothic architecture."

To this view we subscribe; and were it not invidious to point out certain portions of a work where all is uniform in merit, we might dwell upon many of the plates to point out their excellencies: but as it is, we shall only advise our readers to judge for themselves, and we feel assured they will come to no other conclusion than that the work must form a prominent feature in the office library. We had nearly forgotten to state that the author's coadjutor in his labours, Mr. Jobbins, has performed his task in a way only second to the principal.

The Physical Conditions involved in the Construction of Artillery; with an investigation of the relative and absolute values of the materials principally employed, and of some hitherto unexplained causes of the Destruction of Cannon in Service. By Robert Mallet. London: Longman. 1856. 4to. pp. 283.

[second notice.]

In the former notice of Mr. Mallet's work (p. 325), we considered the merits of a method advocated by him of constructing cannon, consisting of several internal voussoirs bound together by external rings, in somewhat the same way as the staves of a barrel are bound by hoops. We endeavoured to show that the method in question, instead of being productive of economy of material, would, as compared with the ordinary construction, require an increased thickness of metal, equal (in a case chosen for its practical applicability) to one-third the thickness of the common gun. We had also occasion to advert to some more general mechanical questions, respecting which the author's views appeared to be erroneous. We now willingly pass from these subjects to others which Mr. Mallet treats far more successfully—his metallurgical investigations. The research with which he has collected and compared the results of the labours of English and foreign experimenters upon the physical properties of metals, is very meritorious. Indeed, the excellence of the work before us in this respect places it in striking contrast to the majority of English treatises on practical subjects, in which the researches of foreign writers are far too much neglected. The frequent consequence of this neglect is, that the same ground is gone over several times, and that the real desiderata of science are not properly kept in view. The advancement of science is best promoted when its students form a republic. It is too often, however, the case that a new book on engineering shows merely the isolated efforts of a single mind. The writer is so intent on his own speculations, as to awaken sometimes the suspicion that his object is rather to advance his own interests than those of science. At all events, there is a real waste of labour resulting from the disconnected efforts of English experimenters. Notwithstanding the enormous amount that has been written upon the strength of materials, it is a positive though remarkable and lamentable truth, that respecting several of the data required to complete the theory of that subject there is a total want of experimental knowledge. To take a striking instance, we may mention the relations between the coefficients of cubical and longitudinal tension and the relations between those quantities and the tangential cohesion of metals and other elastic bodies. So far as we know, there is no systematic collection of English experiments on the effect of cubical compression on the tension of longitudinal rupture; and of the values of the coefficients of rigidity our experimental knowledge is extremely unsatisfactory. The common theory of the strength of beams neglects these quantities, but it is absolutely demonstrable that until they are ascertained the theory will remain very imperfect. Modern experiments are often too *direct*—have too little reference to theoretical science—too often deal with phenomena in the aggregate instead of anatomising them—to be of much value. The same labour that is unscientifically expended in breaking beams and stretching rods would, if directed by the aid of mathematical science, be rewarded by real acquisitions of important knowledge. We want in practical mechanics more of that refined analysis which is exhibited in other branches of experimental science—as chemistry and physiology.

Of the experimental laws arrived at by Mr. Mallet, perhaps the most remarkable is that which he announces respecting the effect which the direction of the transmission of heat through crystalline bodies has in determining the position of the crystals. With respect to cast-iron, he states it as a law that "*the planes of crystallisation group themselves perpendicularly to the surfaces of external contour*, that is to say, in the directions in which the heat of the fluid cast-iron has passed outwards from the body in cooling and solidifying." Mr. Mallet also proposes a law of molecular constitution of crystalline bodies generally, as follows:—

"It is a law (though one which I do not find noticed by writers on physics) of the molecular aggregation of crystalline solids, that when

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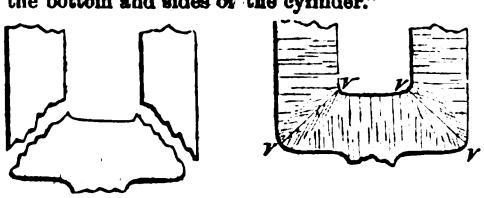
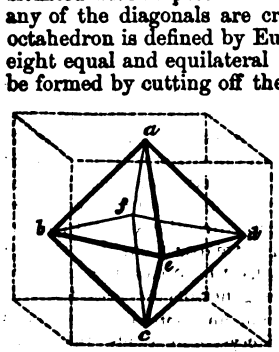
their particles consolidate under the influence of heat in motion, their crystals arrange and group themselves with their principal axes in lines perpendicular to the cooling or heating surfaces of the solid, that is, in the lines of direction of the heat wave in motion, which is the direction of least pressure within the mass."—p. 7.

We have here quoted textually, because we shall have occasion to remark presently on the language in which this law is enunciated. In support of it, Mr. Mallet instances some remarkable and very interesting experiments and natural phenomena showing relations between the direction of transmission of heat and the directions of the surfaces of crystals. Thus if a cylinder of iron pass through a shorter hollow cylinder of uncrystallised lead, and the iron be heated at one end, and heat be so transmitted radially to the lead as to nearly melt it, a radiating crystalline structure will be induced in the lead. Again, it is stated that an uncrystallised wire of brass passing through a red-hot iron tube may be crystallised with a similar radiating structure. A plate of rolled laminated zinc heated to nearly melting by being laid flat on a hot cast-iron plate, will crystallise, "the crystals having their principal axes now all cutting perpendicularly through the plate from side to side; in other words, the planes of internal structure being in this and the former case turned absolutely round 180° of angular direction." (For "180°" ought we not to read "90°"?)

An important practical conclusion is drawn from this law of crystalline arrangement as to the effect of the forms of castings on their strength, namely, that every abrupt change of form of the exterior—every salient and every re-entering angle, no matter how small, is attended with an equally sudden change in the arrangement of the crystals of the metal, and that every such change is accompanied by one or more *planes of weakness* in the mass. The planes of weakness here referred to are those in which the crystals "join and interlace confusedly," and which pass through angles or corners in the surface of the casting. An illustration of this phenomenon is taken (p. 10) from the cylinder of the hydraulic press first made for raising the tubes of the Britannia bridge, and which broke, the end of the cylinder breaking from the sides in the form of a frustrum of a cone, as represented in the accompanying figure. The cause of this fracture was, according to our author, the existence of *planes of weakness V V*, "along the plane of junction of the conterminous crystals formed perpendicular to the external and internal surfaces of the bottom and sides of the cylinder."



A strong argument is thus raised in favour of rounded contours of the surfaces of castings, and we think Mr. Mallet deserves credit for thus calling attention to the subject of the relation of strength to details of form. But we cannot help wishing that he had expressed the law he propounds in more precise language. He says the "*principal axes*" are perpendicular to the heating or cooling surfaces. Now, what does this mean? The expression, "principal axis," is used in many senses in science; in crystallography it means an axis through the centre of gravity of a crystal such that its planes are symmetrically situated with respect to that axis. Thus of a regular octohedron, any of the diagonals are crystallographical principal axes. An octahedron is defined by Euclid to be a solid figure contained by eight equal and equilateral triangles, and we may consider it to be formed by cutting off the corners of a cube by planes passing through the middle points of the sides of the cube. The corners of the octohedron will be at those points, namely, *a, b, c, d, e, f*, in the figure, and the diagonals *a c*, *b d*, or *e f*, are called in crystallography the principal axes; but the planes of cleavage, or those along which a crystalline body is most readily divided, are parallel to the planes of the surface of the crystal; consequently, in the case of the octohedron, they cannot be parallel to these principal axes. Now, if



a casting of iron be composed, as Mr. Mallet states (p. 21), of octohedral crystals, and he really mean what he says—that the principal axes are perpendicular to the surface of the casting, the planes of cleavage will be inclined to it at the angle of 45°. We cannot help suspecting that he has used the expression, "principal axis," inaccurately, for this inclination of the planes of cleavage would be so remarkable if it existed, that it would surely have been noticed by him.

It is to be regretted that any uncertainty should exist on such a subject. We have tried to find out what is really meant, by comparing several parts of the text; but the extremely unprecise use of mathematical phraseology renders it impossible to clearly determine the meaning of the author. At page 213, in a note to the passage above considered, we find :—

"By *principal axis* of the integrant crystal in metallic masses in the act of becoming crystallometrically arranged, under the influence of heat or the pressure due to its motion, I do not necessarily mean the *optic axis*, were such determinable for opaque bodies such as the metals, but *that symmetric axis of the integrant crystal whose position after consolidation of the mass, is found coincident with the direction in which the heat wave* has passed out from the mass, if cooling, or into the mass, if heating; and *which direction is necessarily that of least pressure within the mass*, the pressure being that due to distortion or change of form by contraction or expansion. As matter of observation, this is found to be the longest axis in metals, and perhaps in all other crystalline bodies. But although not ascertainably the optic axis in metallic crystals, future investigation will most probably show, through such transparent bodies as assume in mass the same crystallometric arrangement, that the principal axis as used by me has direct relations to the optic axis."

Here the obscurity of the meaning of the writer is increased by a *petitio principii*. We have, first, a law propounded that the principal axis is in the "direction of the heat wave," p. 7; then, in the note to this passage, we find the principal axis defined to be the direction of the heat wave! Of course, true propositions may be affirmed *ad libitum* by giving arbitrary meanings to the words employed in them. We may truly affirm the moon to be made of cheese, by defining cheese to be the material of the moon.

The statement in the passage just quoted, that the direction in question "is necessarily that of least pressure, the pressure being that due to distortion or change of form by contraction or expansion," does not tend to fix the meaning as to the direction of the principal axis of a crystal, for the direction of least pressure is wholly independent of crystalline arrangement. If any solid, crystalline or not, be subject to any external forces, the pressures at any point of it are proportional to lines drawn in their direction to the surface of an ellipsoid of which that point is the centre; consequently, the direction of least pressure depends on the relation of the external forces, and not on internal structure. Again, we find it said that the principal axis is "the longest axis of the crystal in metals, and perhaps in all other crystalline bodies." This would confirm the supposition that in the case of the octohedron the diagonal is meant.

The reference to optic axes in the last sentence quoted is—to say the least—very unfortunate. Most of the natural metals, including copper, iron, and lead, belong to the cubical system of crystals—that is, the very system to which transparent crystals belong which have no double refraction, and with respect to which therefore the expression, "optic axis," has no meaning.

Having been compelled to dissent from several of Mr. Mallet's conclusions, we the more readily acknowledge the general value of his work. The research and industry displayed in it we have already commended. Many of the views which our space has not permitted us to notice are ingenious and suggestive, and the general impression which we have derived from examination of Mr. Mallet's labours is that they demand attentive, but, we must add, discriminating, consideration.

The expedition for the discovery of the source of the Nile have commenced their journey, starting from Cairo. They comprise twelve scientific or military men, twenty-four artisans, 400 Egyptian troops, camel drivers, boatmen, and servants, numbering altogether upwards of 500 souls. The expense of the expedition is to be defrayed by his Highness Said Pasha. It is to be supplied with provisions and military stores sufficient for two years, and the scientific members are to make a survey of the country through which they pass.

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TRINITY PRESBYTERIAN CHURCH, KINGSLAND.

(With an Engraving, Plate XXXIV.)

Our Engraving represents a perspective view of Trinity Presbyterian Church, now erecting at the junction of the Southgate and Church roads, on the De Beauvoir Estate, Kingsland, for the congregation of London-wall, the oldest Presbyterian congregation in England, and believed to be coeval with the establishment of the Presbyterian form of church government in Scotland. The London-wall Church has long been famous in consequence of Fleming, Hunter, Lawson, Young, and many others known for their piety and worth, having been amongst those who have occupied its pulpit. The style is Decorated Gothic, and although many of its parts are suggestive of studies from ancient examples, yet there is a marked freshness which commands attention. The accommodation is for 600 worshippers on the ground-floor, galleries, we are glad to find, not being contemplated.

The architect is Mr. T. E. Knightley, of Cannon-street, City; and the contract has been undertaken by Mr. Clarke, of Tottenham, for 4240*l*.

ORDNANCE SURVEY OF IRELAND.

A pamphlet recently put into our hands* consists principally of an attack, not only on the corps of Royal Engineers generally, with which we have nothing to do, but an attack particularly on their execution of the Ordnance Survey of Ireland, which the real facts of the case by no means warrant. We wish, therefore, to give our testimony in favour of the accuracy of that survey, wherever accuracy was professed or expected, and which we have had opportunities of closely testing on many occasions since the first sheets were issued. Those parts are the *triangulation*, the *levelling* between the various (we might say innumerable) trigonometrical points, and the *engraving*; these portions of the work, which depended altogether on the Royal Engineers, and Sappers and Miners under their direction, must be pronounced by any impartial and unprejudiced person, faultless, in a work of such extraordinary extent and laborious detail.

The survey of the towns and boundaries, it is but justice to say, is equally satisfactory, as far as the comparative smallness of the 6-inch scale permitted it to be, although it is understood to have been executed by civilians, under the name of "Boundary Surveyors."

It is true, accuracy was not professed in the delineation of the subdivisions of town-lands, which, on the principles of military field-sketching, were merely put in by the eye; and, although all professional men were aware of that circumstance, and so were not misled, the instruction to "fill-in" the town-lands in that way was a great mistake, because it occupied, by what was to a certain degree false, the space that could at any time have been filled up with the reality. But farm fences in Ireland are often in such a state of transition—where, for instance, the fields are changed to a stock-run, and the fences neglected—that it was necessary to say "stop" somewhere, or it might be difficult at last to define what was or had been a fence, or what was merely a ridge in the ground, so completely do neglected "ditches" in an ancient pasture moulder away and become grazing land, however irregular in its surface.

In struggling with this difficulty two courses were open—either of them preferable to the one adopted—the first, as we have hinted, would have been to have left the whole townland a blank, and everything not actually surveyed; and the other, still more satisfactory, would have been to have extended the boundary survey to the holdings, for let farms change or enlarge as they will, there is generally a respect paid to the "neighbour's landmark," though the subdivision between two united farms may be, like the smaller fences, entirely annihilated: without this extension to the holdings, the survey became comparatively useless for the purposes of valuation. Had the tenements been inserted, and with the accuracy of the rest of the work, which is beyond all praise, the Ordnance Survey in Ireland would not only be, as it is, admired and valued by the "upper ten thousand," but it would have been popular with and useful to even the "million."

Eight inches to the mile (40 perches to the inch, instead of to three-quarters of an inch) would have been large enough, and not so expensive as the great 12-inch scale,—whereas the 6-inch scale has been complained of as being inconvenient, and too small for accurate delineation.

Another cause of seeming inaccuracy in the Survey, was the excessively small scale of the index-maps of most of the counties; it is true they were meant to be but indexes to the numbers of the 6-inch sheets, but, in the end, they came to be worked out so elaborately on this insufficient scale (generally half an inch to the mile, often smaller) that a pitiful loss of time must have ensued, and entire accuracy was neither intended nor was it possible to be effected. Still, if all the index-maps had been executed on the one scale—say four-fifths of an inch per mile, or the tenth of the 8-inch scale—they would have formed a valuable and superb map of the kingdom such as no country has yet produced, and which, hung up in the provinces, in the grand jury rooms in Ireland, and in every public office, would have afforded a pleasurable and useful recollection of that great work, the Ordnance Trigonometrical Survey. In support of this statement, we may observe that many of the grand juries, besides having two or three copies of the 6-inch sheets forming the county they represent, have had the index-map of their county set up and surrounded by the indexes of the border counties as long as the scale suited; and, when it failed, the deficiency we have seen made good by manuscript, which but for the irregularity of the scales alluded to would not have been required. At the four-fifths of an inch scale (400 perches to the inch) every parish and every road could have been inserted with accuracy, without the risk of obliteration by its own name, and the great roads could have had their proper character, not as now, on the index-sheets. For want of space as well as topographical knowledge, old abandoned roads, or even lanes, are made by the engraver of the index to represent the leading thoroughfares, and these latter the lanes. Although this is to be regretted, it merely refers to the index-maps, and has nothing to do with the correctness of the Survey, which, of everything that was surveyed, is accurate beyond all praise, and by no means in any way the failure "Nemo" would have the public to believe it is.

* "The Squabbles of the Royal Artillery and Bengal Engineers Examined, and their Duties Discussed." By Nemo. London: Stanford, 1856.

ARCHITECTURAL IMPROVEMENTS OF LONDON.

No. VI.

The next in importance of our modern Club-houses is that called the "Army and Navy," which has a commanding situation at the corner of Pall-Mall and George-street. This structure was designed by Messrs. Parnell and Smith, and, like the Carlton, is founded on an original by Sansovino, but is far from being a direct copy from any particular work of that celebrated architect. It has not the characteristics of attached columns in pairs reaching throughout the ground-floor, the piers between the windows being merely rusticated in horizontal channellings, having their arrisses rounded, and not in accordance with the orthodox manner of Palladio and his followers, but which most assuredly does not evince improvement. The windows in this story are deeply recessed between the piers, and the rusticated work is continued across the columns at each side of their jambs. Above these windows, under the cornice that divides the two stories of which the façades are composed, is a low mezzanine that by no means improves the effect. The first-floor contains more of the distinguishing features of Sansovino, and is separated from the lower one by a cornice embellished with plain moulded blocks. It consists of plain coupled columns (ranging immediately over the piers below) which have Corinthian capitals, surmounted by a highly decorated entablature, consisting of enriched modillions of great projection under the corona of the cornice, a frieze in high relief composed of tritons, sea-horses, boys intermingled with foliage, and fruit and flowers, carved by Nicholls. In the upper cyma-recta of the cornice, at intervals are pairs and single lions' heads. The windows of the upper series between the columns are semicircular-headed, having on each side pilasters with plain moulded capitals and archivolts, and enriched and highly effective trusses, on the faces of which are dolphins. The spandrils between the arches are decorated with representations of trophies and implements of war grouped and carved in a bold and artistic manner. Level with the sills of the windows are projected pedestals, between which are circular balusters, the moulded

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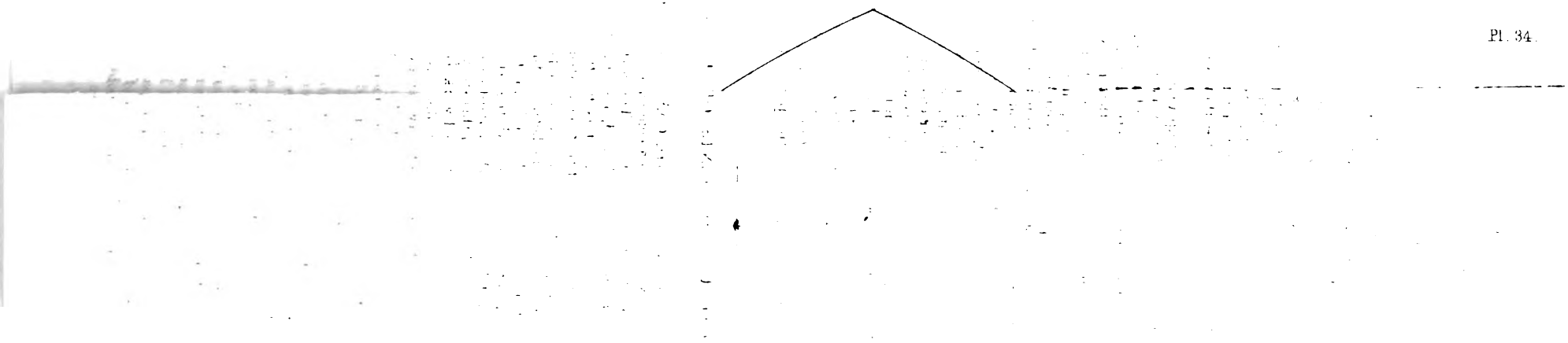

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capping of which is continued across the sub-plinths of the coupled columns between them. Over the principal cornice at the eaves, and ranging vertically with the columns of the first-floor, are dwarf moulded piers, which, with the open balusters between them, form the parapet. The entrance is in George-street, and does not consist of a projected portico, as in the case of the "Carlton," but of three large arches in the centre of the elevation (carried nearly to the height of the intervening cornice between the second story), on the same plane as the main wall, having vermiculated piers and spandrils, with a plain course at the springing, without extra projection. The key-stones of these arches have carved heads on them. The ascent from the foot pavement is by eight steps to the landing of the loggia formed by the arches, and four others to the vestibule within. The great altitude of these arches, and their noble proportions, although without mouldings, give the entrance an imposing appearance. The bounding dwarf-wall next the foot-pavement is treated in a somewhat novel and peculiar manner, having the lower courses of its base, the panels of its pedestals, and the centre portions of its square balusters, vermiculated. Unlike the "Reform" and "Carlton," there are no metal candelabra fixed on the pedestals of the bounding wall, which has in consequence a somewhat unfinished appearance. Our opinion of the effect of the exterior of this production is that, like the Carlton Club-house, it is not quite successful, although a very great advance upon former efforts, and presents, as a whole, a large amount of ornate splendour and magnificence. Bearing in mind that the engaged columns of the first-floor are of the same material as the main walls, and not in colour, polished, there is more real harmony of effect in the building, the eye not being startled out of its propriety, as is the case when red and highly-polished columns are harshly intermixed with sober stone. The ground-floor contains a very spacious coffee-room, morning-room, and strangers' coffee-room, the decorations of which are highly effective, partaking of the Renaissance character, and were executed by Messrs. Jackson, from models prepared expressly by the celebrated M. Joyau.

One of the greatest improvements effected at the lower end of St. James's-street was by the erection of the "Conservative Club-house," which occupies the site of what was originally the famous Thatched-House Tavern. This Club-house was designed conjointly by the late Mr. Basevi and Mr. Sydney Smirke, and, although having the advantage of a very large frontage, is in some portions of it extremely faulty in design, more particularly in the ground-floor portion of its façade. Like all our modern Club-houses, it consists of two stories only above its basement. In the lower range the Roman-Doric order is employed, and in the upper one the Corinthian is adopted, neither of which are however fully enriched, and the whole presents a somewhat tame and poverty-stricken expression, arising from the want of a due distribution of enrichment, and more boldly defined mouldings. In the Doric order the metopes are omitted; there is also an absence of the modillions in the Corinthian cornice, which has also a plain frieze. The entrance, instead of being in the centre of the front, is at the north end, with a large window in the corresponding one at the south, in which an attempt has been made to make it harmonise with the doorway, but without success. This entrance and window have the usual Doric characteristics, and the upper part of the cornice is continued across the elevation, but the features of its frieze are entirely changed by the substitution of trusses instead of the triglyphs, and oblong raised vermiculated panels for the metopes, which innovations, as may be supposed, tend to destroy the character of the order, and to break up the harmony of this portion of the composition. Over the cornice a continuous balcony is projected, composed of open square balustrading. In the upper story there is a large window at either end, on each side of which are clusters of plain pilasters having Corinthian capitals. The intervening space is deeply recessed and filled up by six three-quarter engaged columns, between which are five pediment-headed windows, with meagre dressings around them, and having the appearance of being squeezed in between the columns. Occupying the same depth as the capitals of these columns, is an enriched frieze of foliage, finely executed, the effect of which is in a great measure, however, destroyed by its abutting at each end against the leafage of the capitals, giving the whole a confused appearance, instead of being distinctly separated from them by a plain margin at each end. Above these capitals is an extremely plain entablature, at variance with the usual characteristics of the order, and over this the parapet is composed of pedestals, between which are circular balusters crowned with the usual coping. The lower story is rusticated with faint horizontal chanellings, and the bounding dwarf-wall is poor, and trifling in the extreme. The design of the candelabra on the pedestals at each side of the entrance doorway, too, is worse than abominable. We regret to observe that many portions of the stonework of this club-house, particularly the coping and balusters of the balcony, and parts of the pilasters, are showing unequivocal symptoms of decay. The apartments of the interior are spacious and commodious, and arranged with great elegance. The plaster embellishments and scagliola work were executed by Mr. Vincent Bellman, and the encaustic paintings on the walls and ceilings by Mr. Sang, being among the first of the kind executed in our London interiors, in which polychromy was extensively employed. We most cheerfully admit that, with all its faults, the Conservative Club-house forms a decided advance on some of the older structures of the same description in St. James's-street, amongst which may be instanced, that of "Brooks'," with its trifling puerilities, and "Crockfords'," with its "four thin slices of pilasters," starved details, and heavy ugly cornice, externally,—and internally the elaborately overdone decorations of the Louis Quatorze period, as corrupt and flimsy as could possibly have been conceived.

MECHANICAL EQUIVALENT OF AN UNIT OF HEAT

Sir—A table has appeared at page 331 of your *Journal* (for October), in the report of a paper by Mr. Rennie, which might lead those not specially acquainted with the subject to suppose, that my computations relative to the mechanical equivalent of an unit of heat were at variance with the experiments of Mr. Joule on the heat produced by fluid friction. I beg leave to make the following statement, in order to show that such a supposition would be erroneous.

Previously to the publication of Mr. Joule's experiments on the heat produced by fluid friction, I had made and published a computation of the mechanical equivalent of heat, founded on De la Roche and Bérard's experimental determination of the specific heat of air at constant pressure (viz. 0·2696), the result of my calculation being 695 foot-pounds per degree of Fahrenheit in a pound of liquid water, being less by about one-tenth part than the value considered most probable by Mr. Joule. No valid reason was known at that time for doubting the accuracy of De la Roche and Bérard's experiments, which were accepted as a standard authority by all writers on Physics.

Soon after the publication of that computation, there appeared in the 'Philosophical Transactions,' for 1850, Mr. Joule's paper, describing his final and most accurate series of experiments, from which he deduced that value of the mechanical equivalent of heat which has since been adopted by all scientific inquirers on the subject, viz., 772 foot-pounds per degree of Fahrenheit in a pound of liquid water. On studying that paper I was convinced, that from Mr. Joule's mode of experimenting, his result must be accurate to within $\frac{1}{200}$ of its amount at furthest. I therefore immediately prepared a supplement to my previous paper, in which I revised all my calculations in conformity with Mr. Joule's result; and in particular I showed, that the experiments of De la Roche and Bérard, up to that time implicitly relied on by scientific men, must have been erroneous, and that the value of the specific heat of air at constant pressure must be about 0·24 instead of 0·2696. That supplement was published in 1851, and follows immediately after the original paper in the 20th volume of the Transactions of the Royal Society of Edinburgh. In 1853, the specific heat of air at constant pressure was for the first time determined accurately from experiment by M. Regnault, and found to be 0·2379, being practically the same with the result of the theoretical computation above referred to. A theoretical computation from the best data attainable at the present day gives 0·238.

W. J. Macquorn Rankine.

Glasgow, October 13th, 1856.

A letter from Barcelona states that the directors of the Northern and Eastern railways had left for the frontier, accompanied by their chief engineers and the engineer of the government, to fix the point at which the two lines are to meet, and their junction with the Pyrennean network.

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METROPOLITAN BOARD OF WORKS.

As we fully anticipated, the chief labours of the Metropolitan Board of Works have ended in smoke, and are as yet abortive; in fact we could not reasonably have looked for any other result from a body so inefficiently constituted. We had hoped, however, if the board did fail to grapple successfully with large and momentous projects that came under their consideration, that at any rate they would have effected some improvements on a small scale. In this, however, we have also been disappointed. Amongst minor matters it will be remembered that as long back as March last, Mr. D'Iffanger brought forward a motion in reference to the "nomenclature of streets," to the effect that 'when more than one street in the metropolis is called by the same name, to alter the name of any or all such streets except one." We have before commented upon this subject, showing the absurd and imperfect manner in which our streets and squares are named. In some instances the street or square is actually not named at all. One square has eight thoroughfares leading into it, and consequently has sixteen external angles, and yet has only *one* solitary indication of its name, and that has three letters broken out of seven of which it is composed. In the street also leading into this square, there is scarcely one name perfect, owing to the fragile material of which they are composed. Glass is a valuable and useful material for very numerous purposes, but is not at all adapted for the naming of streets, and ought to be abandoned. The motion of Mr. D'Iffanger appears, like many other acts of the board, to be still laying dormant, for as yet we have seen no signs of its practical illustration, although several months have elapsed since the subject was first discussed. Until the existing Metropolitan Board of Works is entirely dissolved, and replaced by really clever and professional men, thoroughly energetic and practical, we have no hope of amendment, either as regards works of utility or ornament. What can be expected from men, the majority of whom voted for the doing away with all porticoes in London, designating them as "eye-sores" and 'fourpost-bedstead sort of things?"

DRAINAGE OF THE METROPOLIS.

Mr. J. R. M'Clean, C.E., has laid before the Metropolitan Board of Works his plan for the precipitation of the Thames, and the utilisation of the sewage as manure. His proposition is to do away with the main drainage sewers and reservoirs on both sides of the Thames, and to construct a conduit capable of conveying the whole sewage of the metropolis from the pumping station at West Ham, passing through the rich agricultural districts of Essex, to a point on the sea shore between the estuaries of the Crouch and Blackwater rivers; this conduit to be made available for the purposes of sewage irrigation throughout its entire length until it reaches the German Ocean. From West Ham to a place called Battle-bridge, over the river Crouch, the conduit would pass through the uplands of Essex and would be constructed as a tunnel or covered canal. From this place to its mouth it would run through the marshes adjoining the river Crouch, a district almost devoid of population, but extremely rich in agricultural produce, and where upwards of 500,000 acres of land may receive the benefit of the sewage of the metropolis. For this latter portion of its length it would be sufficient to construct the conduit generally as an open canal, following the course of the river until it arrives within two miles of Burnham, whence it would be diverted in a north-easterly direction to the sea. The sewage of the whole of the southern district may be collected at a pumping station near Southwark-bridge, and be carried by means of pipes over the river to the Aldgate sewer, through which it would flow to the proposed main conduit. The expenditure for this work Mr. M'Clean estimates at 1,600,000*l.*

The following observations were made by Mr. M'Clean on presenting his plan to the board:

"The proposed outfall sewer will commence by a junction with the one proposed by your engineer near the pumping station at West Ham, at the point where the high level intercepted sewage and the low level sewage, pumped up, flow through the same channel. The level of the top water at the junction will be 16 feet above Trinity datum, as shown in the plan of your engineer. The conduit will pass over the North Woolwich Railway by means of an iron aqueduct, and under the Tilbury Railway near its junction with the Eastern Counties Railway. The railway will be raised two feet for the purpose of allowing the water to be maintained at a level 14 ft. 6 in. above Trinity datum in the conduit at the time of its maximum discharge. After passing under the Tilbury line it will proceed to Ilford, crossing Barking-creek above the navigable part of the river, and thence, without interfering with the level of any road, to the marsh land near Battle-bridge in the valley of the Crouch, to which place the tide at present flows. The conduit will be a covered sewer 24 ft. diameter, as far as the marshes, whence, with the exception of a length of about two miles covered near Burnham, it will be an open sewer until it reaches the German Ocean. The fall will vary between five and six inches per mile, and the velocity between two and three feet per second, or between 1½ to 1¾ mile per hour, and there will be an uninterrupted discharge at all times of tide. No pumping will be required between West Ham and the German Ocean. The conduit will be capable of discharging 52,000 cubic feet per minute, which is the maximum sewage and rain-fall estimated by your engineer to flow through the sewers of the northern, southern, and western districts of the metropolis."

NEW WESTMINSTER BRIDGE.

Digest of Evidence taken before the Select Committee of the House of Commons.

ARCHES.—*Mr. Stephenson*: Great discussion took place, in the first instance, with regard to the spans to be adopted in the arches of this bridge. If he had been called upon to design a bridge in such a situation, he should have preferred making the spans as large as possible, 200 feet at least, and to have used cofferdams. In order to reduce the contingency of cofferdams, would run the risk of employing larger arches, putting perhaps, six, seven, or eight tons to a square foot upon each pier, instead of two or three, which, by reducing the span of the arches, Mr. Page has arrived at. He has diminished the pressure, or the danger from subsidence, by reducing the arches. There would be no difficulty in keeping the bridge low as regards the surface of the water, and the inclination of the bridge exceedingly level.——*Mr. Rendel* would remove the whole of the arches of the old bridge before he began the new.

BOOMS.—*Mr. Fowler* believed that booms were not contemplated in the plan. He would have built a granite string as part of the permanent structure; but it would answer the purpose if made of timber, as no doubt was intended by Mr. Page.——*Mr. Hawkshaw* did not see the necessity for booms, and certainly not if a course of granite were built round the upper part of the pier. He would have made the granite slab on the top of the casing shorter, and then another course of granite, so as to have a large surface of granite to resist the shock of boats.——*Mr. Stephenson*: A bridge ought not to require booms.

BRICKWORK.—*Mr. Page*: The piers will be built up with brickwork. There are spaces in the piers as in Hungerford piers left to be filled up with concrete; those spaces are proposed to be filled up with brickwork instead of concrete.

COFFERDAMS.—*Mr. Rendel* would put a dam quite round the pier, inclosing the site of the new pier as well as the old, and thinks that is a circumstance in favour of putting the new bridge immediately upon the site of the old one. The removal of the old bridge he believes is a matter of much more difficulty than has yet been considered. He believes it would be necessary, for the safety of the river, to put centres under the arches.——*Messrs. Rendel and Simpson*, seeing that Blackfriars-bridge has begun to subside, notwithstanding its having bearing-piles, and knowing the attempts that have been made to keep up Westminster-bridge, come to the conclusion, that to make the piers of the new bridge unquestionably secure, it was desirable to resort to the old mode of cofferdams, and to found the piers upon the London clay, at such a depth as would make their footing safe beyond all question. With cofferdams the expense of forming foundations can be calculated; but with tide work, dealing with such ground as the bed of the Thames, experience proves that the cost of the work cannot be calculated in money or in time. The works that have been done in the effort made to keep up Westminster-bridge, and the quantity of stone that has been thrown down in all parts of the bed of the river round its piers, will cause very great difficulty when the new bridge comes to be built upon those portions of

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Cofferdams (*continued*)—
the site of the old bridge where the foundations are in common. They consider there will be considerable difficulty in taking up the foundations of the old bridge, unless dams are employed. If driven to use a cofferdam, then most unquestionably they would not use concrete, but stone. Even if Mr. Page's plan were desirable to be adopted, they think that the nature of the construction demands that every part should be seen by the workmen, as nothing is so important to the stability of the work as the piles being close and the iron ties secure. There is the greatest difficulty in driving those piles with the requisite degree of nicety, and there is also a very considerable amount of difficulty in getting divers to do iron work, such as the fastenings of these ties, securely; therefore, they would rather have them executed with a dam, particularly that part of the work which will have to be built upon the sites of the present piers. If cofferdams be resorted to, it would take a longer time and increase the expense. Cofferdams are not necessary in the construction of all bridges.——*Mr. Stephenson*: Cofferdams are impracticable on account of the spans of the arches being limited to 120 feet.——*Mr. Simpson:* Cofferdams would be perfectly applicable in building a new bridge, but by their use, the building would occupy five years——*Mr. Hawkshaw*: If money were no object it doubtless would be better to make use of cofferdams, and to build with granite; but, if money is limited, then Mr. Page's mode is one that may be adopted with safety.—[Mr. Page's reasons for dispensing with cofferdams will be found at page 343, *ante.*]

Concrete.—*Mr. Rendel*: Having regard to the improvement of the Thames as a navigable river, he objects to a deposit of concrete outside the iron casing as a means of preventing the river from deepening its bed close to the piers. With Mr. Page's mode of construction it would be very desirable. He apprehends that it would be quite impossible as a practical question to maintain any uniform line of bed to the river; it is well-known how readily rivers alter the course of their bed, and that is very difficult, particularly under the arches of a bridge, to make the river retain any particular form unless it is done by coercive measures; he apprehends that the gravel would be scoured away, and the concrete would then begin to break up. The question to his mind, is whether it is prudent so to build the piers of a new bridge as to require such a deposit of concrete for their safety.——*Mr. Stephenson* thinks dredging out the gravel and surrounding the piers by a deposit of concrete would be an adequate provision if what is called the *régime* of the river remained the same. He thinks it is a very similar provision to what Mr. Rendel made in the Lara bridge; he protected the bottom of the river from scour by stone and by clay; that has remained for many years, and he thinks it is likely to remain for many years longer. If a marked improvement in the Thames be looked forward to, he thinks it would require rectification from time to time. He does not think that the probable additional scour would endanger the structure; at all events, if there was any danger it would be easily met by putting in concrete, which is a great deal harder than the stone of Westminster-bridge.——*Mr. Hawkshaw* would not like to put a bridge upon concrete alone. Has lately used cast-iron cylinders on the Thames for a bridge which he has just been building at Staines; there he put in brickwork and cement—thinks the brickwork could sustain the bridge without the casing; does not know that the concrete would. If there were a column of concrete thirty feet high, it would be sufficient to sustain the bridge so long as it was surrounded by the gravel; but if the gravel were washed away, and a column of concrete left standing at that height, it would not be sufficient. Mr. Page's concrete is as hard as flint; a sharp-pointed rod will scarcely produce any effect upon it.——*Mr. Fowler:* The concrete is better and more permanent than the Portland stone used in the existing Westminster-bridge; it is better material.

Cylinders.—*Mr. Hawkshaw:* There are a number of bridges constructed upon analogous principles; for instance, the Rochester-bridge, by Sir W. Cubitt; and the Chepstow-bridge, by Mr. Brunel. All bridges which are supported upon casings of cast-iron, and which are filled up with brickwork, or concrete, are, he considers, analogous to this bridge in some degree. There are great numbers of bridges of that class; it has become a favourite mode latterly of erecting bridges when they are wanted to be constructed rapidly. He prefers this to

Cylinders (*continued*)—
a bridge constructed upon cylinders, though he would not hesitate himself to construct a bridge in the Thames on cylinders; thinks that it could be done with security, and so as to make a very good job.——*Mr. Stephenson:* Would not adopt cylinders in this situation. He has employed cylinders extensively in Egypt for his bridges over the Nile, where the silt was excessively fine, and no foundation could be got. He sank cylinders 7 ft. 6 in. or 8 feet in diameter to a depth of 40 or 50 feet; then those piers were filled in with concrete or masonry. Is quite prepared to admit that hereafter the cylinders themselves will decay. He will not live to see it. Then the bridge will still have masonry to stand upon after the cylinders have gone, therefore the cylinders in that case are merely employed as a temporary expedient to get down to a deep foundation. He does not thus apply the iron in the hope of its being there two hundred years hence. When you get to a watertight bottom or a clay bottom, a cofferdam is the thing; the cylinders are only used where you cannot get any foundation at all, except at a great depth; when you use a cylinder, there is one huge pile instead of a great number of piles; but then a cylinder is used where piles cannot be driven properly. Piles could not have been driven into the delta of the Nile—at least, he could not have known where they would have gone to.

Durability.—*Mr. Hawkshaw:* If the bridge endure 100 or 150 years, as it certainly will do, without requiring material repair, he considers it practically permanent, or at least sufficiently so for the requirements of the case. Has no doubt about its being a structure of very considerable durability. As regards the internal works of the pier, he looks upon them, speaking of those things as practical men are in the habit of speaking of them, as being pretty nearly indestructible. With regard to the cast-iron casing, there is not the same amount of experience as to its durability in situations of that kind which there is of other materials; and no doubt any opinion upon that point must be expressed with more caution, because there are not any cases where cast-iron has been used in former times in that mode for the purpose of sustaining structures of this nature. Has no doubt at all that a structure like Mr. Page's will endure for a long period of time.——*Mr. Fowler:* Before the iron casing was affected considers that the bed of the river would have taken a permanent form; and therefore, there would be no scouring to be apprehended that would affect the foundations, which are guarded at present by the iron casing. Believes that by the time the iron casing gave way, it might be dispensed with altogether. The stability of the bridge would not be affected at that period of time by the iron casing in any way whatever. Practically it would be as permanent as a granite pier, although it is possible that a solid granite bridge would last a longer time than this bridge; but for all practical purposes, the period of time would be so remote, that he should call it a permanent bridge in the most extended sense of the term. He thinks when you get over 150 years, that it is not a matter of consequence how much a bridge of this kind extends beyond that period, before some little attention may be given to it. He should put 150 years as the minimum which he should give to this bridge, before it really required any attention whatever. The bridge might be made to last several times 150 years, provided something should occur to require attention, and provided that attention was paid to it. For instance, supposing some interference with the bed of the river took place by the erection of some improper works. Any works which would materially interfere with the bed of the river, so as to cause a scour there, would be improper works. Supposing all these improper things to take place, and the stability of the bridge to be affected by them, it would be quite possible to provide against the consequences of such a state of things. Therefore in his opinion the permanent character of the bridge would not be altered by the possibility of its requiring in an indefinite period of time some further work, especially when it is borne in mind that that is an improbability founded upon an impropriety. The bed of the river has been mainly affected by the removal of London-bridge. At the present time the low level of the water at Westminster-bridge is so nearly similar to the low level of the sea, that there is only 10½ inches difference; so that he presumes that the causes which the removal of London-bridge has kept in operation for a great many years, must now very nearly, if not altogether, have ceased.

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FOUNDATIONS.—*Mr. Rendel* stated the reasons for himself and Mr. Simpson coming to the conclusion that the scheme is defective in one particular detail, *i.e.*, in the construction of the piers below water. These are, looking at the great changes that are taking place in the depth of the Thames, commencing from the period when Old London-bridge was removed, and continuing up to the present moment, and which are almost certain to go on, which changes imply the removal of nearly all the gravel of the bed of the river down to the London clay; seeing those changes, and that this bridge is founded upon the principle of a composite pier between the level to which he believes the Thames will ultimately deepen its bed, and low-water, a depth of between 12 and 13 feet, he considers that the foundations are not of that permanent character which it is all-essential in his judgment that a metropolitan bridge of such importance as Westminster-bridge should be. He felt that this conclusion was justified by the subsidence which has taken place in Blackfriars-bridge, which although not piled with bearing as Mr. Page is piling Westminster-bridge, was considered, from the circumstance of its having bearing-piles, a safe bridge; and when Westminster-bridge began to sink, it was repaired at a very enormous cost under the idea of Blackfriars being a safe bridge, from the fact of its having bearing-piles. Seeing that Blackfriars-bridge has begun to subside, notwithstanding those bearing-piles, and knowing as he does all the attempts that have been made to keep up Westminster-bridge (a thing impossible, as the results show), he came to the conclusion that, to make the piers of the new bridge unquestionably secure, it was desirable to resort to the old mode of cofferdams, and to found the piers upon the London clay at such a depth as would make their footings safe beyond all question, whatever might be the deepening of the river; for he regards the improvement of the Thames as a navigable river of the utmost public importance, and considers that anything done to uphold any bridge, more especially a modern bridge, that would occasion interference with the deepening of the bed of the river, must be injudicious. He considers that the river should be encouraged to improve itself, not only as a drain, but as a navigation; it is all important as a navigation. Therefore he feels that the mere circumstance of these piers requiring, in the estimation of the engineer, a deposit of concrete on the outside of these cases of iron, as a means of preventing the river deepening its bed close to the piers, is an objectionable thing; and that it would be a safer and better arrangement for a bridge of this importance to obtain security by founding the piers at such a depth as should place them out of the reach of any scour that could take place in the bed of the river. Experience has proved that the plan of putting foundations in at such a depth as stated, beyond the reach of any change in the bed of the river, is, as far as human knowledge goes, a plan which gives permanent security. Putting concrete around the outside of the piers is to prevent the river from deepening its bed close to the piles. Objects to the principle of the bridge, which objection is increased by the conviction, as to the deepening of the river. He cannot draw any analogy between a foundation formed on piles cut off in the London clay, and then covered by a strong grating of timber, such as there is in London-bridge, and a series of piles standing up in the way those of Mr. Page's do, because in this case there is no uniform distribution of the weight to be carried. Again, supposing the iron casing to be perfectly sound, though there is great difficulty in making it sound below low-water, where you cannot see what you are doing; but even supposing it to be perfectly sound, the concrete which is brought up from the gravel will be liable to disturbance by the least settlement or the concussion of barges. He apprehends that there would be no certain uniformity of bearing, and objects to founding the iron piles upon gravel even if as hard as concrete. Would not interpose a third description of ground in the foundation. Considers that securing the piles into the London clay, if it had been possible, would have destroyed the foundation. At Portland is using screw piles to a very great extent, and he cannot possibly get any screws more than about five feet into the clay, which is not so strong as the London clay. After the bridge was constructed, even if the piles remained perfect, the tremulous motion (for there must be some motion in the piles if the gravel or concrete should be disturbed) would materially affect the stability of the pier. Under all the circumstances of the case, he thinks the best

Foundations (*continued*)—

plan of proceeding would be to retain the present site and general character of the bridge, but in lieu of founding the piers in the manner now executing, to found them within cofferdams; the piers and abutments being brought up from 38 feet below Trinity high-water mark. He sees no reason for changing its architectural character.——*Mr. Simpson* concurred generally in Mr. Rendel's evidence as to the defects of the proposed construction of the foundations, and the necessity of piers of solid masonry founded in the London clay.——*Mr. Stephenson* said he should certainly hesitate very much in advising the Committee to stop; on the contrary, after having examined the work, thinks that there is nothing to fear in going on with it. The only question which rests on his mind is, as to the durability of the iron. Did not apprehend that in driving the piles and plates below low-water, there would be much difficulty in ascertaining whether the lower plate had reached a solid bed or bottom in the clay. It would be shown in the driving whether it reached a good foundation or not, and the piles may be driven through gravel into the London clay without any serious or injurious result. He should not have any hesitation about the Thames gravel, having himself built very heavy structures, merely keeping the gravel in. Has no doubt as to the foundation being sufficiently secure, supposing it to remain in the state in which it was put in. Believes that gravel between the rows of piles may be quite as compact as any concrete put in upon it. In some foundations he has washed the gravel and put it in without any lime at all; is as strong as concrete itself. It allows the filtration of water, and therefore is undesirable; but in places where the foundations are constantly exposed to moisture, wet gravel is just as good as concrete. Admits that the plan may be perfectly sufficient, but it is not the system which he would have adopted had he been called upon to design the bridge. There is a continuous series of cast-iron arches, fitted together accurately; they may be taken to be almost absolutely one mass. The river is from 1200 to 1300 feet wide there. Never knew a continuous series of iron work of that length which would not by expansion or contraction be fractured in many parts of it; it could not be kept in an easy state. In the Britannia-bridge provision is made for the tubes to roll and extend out, as they do daily, to the extent sometimes of 2 inches, and 2½ inches in summer. Believes the extreme variation is 4 inches; that is on about 1200 feet; very much the same length as this. In the High Level bridge at Newcastle, which is a continuous series of arches, also of the same kind as this, provision is made to allow the arch to be as easy as possible. Thinks provision for this might be made in the design; some alterations would be necessary, being quite sure that that series of arches would injure each other. If you attempt to tie in a mass of cast-iron tightly between abutments, something must give way. With respect to the character of the works already executed, he considers that they have been done in a very masterly manner. In reply to the qustion whether, if a heavy scour should take place, there would not be some danger of the gravel being worked out from beneath the concrete, he referred to Colonel Lloyd's levels, taken on the tides of the Thames, which were published in the "Transactions of the Royal Society," in 1831. He had examined them, and the facts are so simple and so clear as to induce him to think that the scouring really could not take place. It is evident that, as regards the scouring of any river, when you remove obstacles from it you increase the quantity of water flowing from the sea, and increase the quantity of water which must flow back again; therefore the velocity is increased, and consequently the scour is increased. But that can only go on in those parts of the river where the low-water is considerably above the low-water at sea. He finds on referring to these levels, that the low-water in the pool has arrived within two or three inches of the low-water at Sheerness. The low-water at Westminster-bridge at present varies, say from 8 to 10 inches; but that fact alone satisfies him that not even the coarse gravel of the Thames, or the fine gravel, will undergo any great change of level by any change that you may make between London-bridge and Westminster-bridge. Even the formation of quay walls between those bridges, and improving the form of the river in every possible way in that distance, could not produce more than 10 inches lowering of the tide. Therefore that increased scour, he is perfectly satisfied, would not endanger the foundations of the bridge, even as

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Foundations (*continued*)—

laid by Mr. Page. He is of opinion that there is no reason to apprehend any considerable change in the bed of the river. Had he been called upon to design a bridge in such a situation, should have taken care to have made the spans as large as possible, and to have used cofferdams; but to use a cofferdam now with such spans, would actually fill the river up; you could not do it. Therefore if you once fix the spans to be adopted, you negative the adoption of cofferdams. He should have preferred to have used cofferdams, and to have made arches with 200 feet span at least, but in his opinion the security of the work could be well seen to by means of divers.——*Mr. Hawkshaw* stated, generally, that from his views of what such structure should be, he saw no cause for not proceeding with it. There are small matters of detail which probably he should alter, but did not doubt that every engineer who might be consulted would alter them differently. Believes the bridge may be completed in the manner in which it is commenced, so as to make a durable structure, within certain limits; and looking at the questions of time and expense, and the importance of removing the old bridge, should proceed with the new bridge rather than begin upon another plan, which would involve its removal, or that which would lead to very slow progress, the use of cofferdams.——*Mr. Fowler* perfectly agreed with Mr. Hawkshaw as to taking the responsibility of saying that the bridge is sufficient, may be built with perfect security, and would be a permanent structure; but would adopt a projection of the granite, so as to protect the caps of the piles from the possibility of being injured.

Granite Plinth Course.—*Mr. Stephenson* considered that the granite course of the superstructure should commence at the lowest low-water mark. In building a pier, engineers ought to adopt the general principle of arriving at something like homogeneity in the parts which have to bear a uniform weight; the mixture of wood and concrete and iron was the novelty of the case. Although one or two of the piers may have been finished in that way, did not recommend its continuance in that shape; but does not attach very much importance to that, because he has taken the area of the pier within the shell of granite, and assumed that the granite plinth placed upon the pier-top as now finished, should not bear upon the granite shell outside; that it should be merely a projection over that, and therefore that the inequality of pressure should be avoided by confining the weight of the bridge entirely to that space within the granite shell. The open joint might afterwards be filled up with cement after the bridge has come to its bearing; therefore does not attach much importance to that, because taking the limited area of pier, and taking the weights of the bridge, finds that the weight would not exceed 2¼ tons per square foot; that it would not quite reach that. There is scarcely a good house in London which has not fully as much weight as that upon its foundation; does not therefore think that there is any great apprehension to be based upon that circumstance.——*Mr. Hawkshaw* is of opinion that the piles should be a little shorter, and have a broad face of granite, so that any barge would strike that and not the piles, thus rendering booms quite unnecessary. Thinks that the granite isolated blocks placed upon each pile, the interstices being filled with concrete, instead of being separate and detached blocks, should be a solid course of granite, extending all across the pier of 3 or 4 feet deep, and projecting sufficiently to make a fender against boats.

Headway.—*Mr. Hawkshaw* thought it desirable to have one uniform headway in all metropolitan bridges; that it would be very advantageous for the commerce of the river, and that the headway of 20 feet might without difficulty be increased to 25 feet.

Iron Piles or Casing.—In consequence of one of the firms which tendered for the contract objecting to the use of wrought-iron piles and plates in the foundation, cast-iron piles and plates were subsequently decided on. Messrs. Rendel and Stephenson think it would be better if the iron piles did not act as bearing-piles as well as casing piles.——*Mr. Stephenson* stated, that as far as the stability of the pier goes, or its capability of withstanding any pressure that may hereafter come upon it by the superstructure, he has no hesitation in saying that there need be no apprehension upon that point. The mere question is as to the permanency of the structure in itself, and the arrangements which have been proposed by Mr. Page for

Iron Piles or Casing (*continued*)—

protecting the pier from the scour hereafter in the river. He also stated that the application by Mr. Page of cast-iron piles, as a shell to the pier, is quite novel, and he considers, to some extent, objectionable, for a structure of this character. Mr. Page seems to have felt, he thought, to some extent, that a cast-iron shell to a pier was objectionable, on account of boats running against it. There is no cast-iron shell which one can put there, round a mass of concrete or piling, which would not be cracked immediately on a bump from any barge floating in the Thames; it would be broken. With a view of meeting the difficulty, Mr. Page has stopped the cast-iron piling at six feet below low-water, evidently with a view, as he had himself stated, of protecting it against that contingency. He said that it is not a contingency, but that it is, in fact, a certainty, because he had had accidents of that kind, and has known of several where the momentum of a vessel would crack any cast-iron shell like a lobster-shell; there is nothing which can resist a blow of that kind. Accidents have taken place in the river, at the Victoria Docks, within the last fortnight or three weeks; a vessel went against some cast-iron piling, and it was all broken to pieces as if it had been an egg-shell. Therefore, Mr. Page, after adopting cast-iron piling, has properly, he thought, stopped it within six feet of low-water. It is a novelty, as far as its application to a work of great permanency is concerned. Bridges over the Thames are meant to last, not for 50 years, or 100 years, but for 400 or 500 years. Engineers have been in the habit of applying cast-iron to wharfing, for making a wharf on the river side. Knowing that cast-iron is liable to decay, whenever immersed in water, or exposed alternately to wet and dry, it might be said to be objectionable in the application to wharfs; but that is not so. Engineers apply it there because they feel that to make cofferdams upon a large scale for the purpose of getting masonry into a greater depth and of making it extremely permanent, would incur an expense which would be inordinate to the object in view. Therefore cast-iron as wharfing may be regarded as an expedient employed for the purpose of bringing property into play. It is done at a much less cost than masonry, in much less time; but with the knowledge that it must be repaired, perhaps in twenty years or in thirty years. Considers that cast-iron piling in this case is objectionable, because the work is evidently meant to be very permanent. We know also (for the experiments have been very extensively made) the decay of cast-iron when exposed to moisture. Mr. Mallet, of Dublin, laid before the British Association some years ago a most elaborate series of experiments on the decay of cast-iron, both in salt water and in brackish water. Those experiments lead inevitably to the conclusion that in moist situations, and more especially where there is any brackish water, cast-iron is subject to decay. That being the case, can hardly agree with Mr. Page that a cast-iron surface is a desirable one, although removed from blows from the navigation. There is a peculiarity here; Mr. Page has placed upon the cast-iron piles a shell of granite slabs, 18 in. thick, and he fills up the whole area of the pier with piles and concrete. Upon that, when brought above low-water, he builds his granite pier. It is a rule now amongst engineers, that whenever any great weight is to be superimposed upon a building, that building should be made as uniform in its character as possible, that it should resist equally throughout the whole area the pressure upon it. Here there is timber, piles, concrete, and granite on the outside; they may be made to approximate very nearly perhaps in strength, but the difficulty is in making them all bear equally; if they do not all bear equally, subsidence may take place in one part and not in another. In all cases, even in a common house, you always see that the thin walls subside and the thick ones do not. That would not be at all a serious objection. Did not imply that the pier would not be able to bear any superstructure which might come upon it. On considering the question, if this structure of Mr. Page's were removed away from the old bridge, should not have much hesitation in saying that it would be a permanent structure, at least one of considerable durability, notwithstanding the objections raised.——*Mr. Hawkshaw* said the only extensive series of experiments which have been made in reference to the durability of cast-iron that he was acquainted with were made by Mr. Mallet, of Dublin, who was asked by the British Association to make experiments upon the durability of cast-iron and of other irons also, and to report

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Iron Piles or Casing (*continued*)—

from time to time to the British Association. These experiments were made with great care, and they continued for some years. Has referred to his third report, which was made to the British Association at its meeting at Cork in 1843. Assuming the accuracy of a very large series of carefully-conducted experiments on the corrosion of cast-iron, finds that the cast-iron plates and cast-iron piles which are proposed to be used at the Westminster-bridge would endure for a very long time. Mr. Mallet immersed various specimens of cast-iron in clear fresh river water: the samples of iron were Scotch cast-iron, Welsh cast-iron, Staffordshire cast-iron, and Irish cast-iron; these were exposed in the waters of the Liffey sunk in a box for 732 days, or about two years; the result appears to be as follows. The mean corrosion per square inch of surface is one grain; including the decimals, 1·011 grain. The weight of a cubic inch of iron is 1700 grains, and this was the amount of corrison in two years. The result of that would be, that supposing only one surface of cast-iron plate were exposed, it would take 3362 years totally to corrode a plate an inch thick, but if both surfaces were exposed, it would take 1681 years to eat through a plate an inch thick, assuming that experiment as the basis. The next experiments of Mr. Mallet were in foul river-water in the Liffey opposite the junction of the Poodle river, on a bottom of putrid mud: the result which Mr. Mallett arrived at was, dealing with it in the same way, if one surface was exposed it would take 1200 years to eat through the iron, if both surfaces were exposed 600 years. The next case is where he immersed cast-iron in sea-water in Kingstown Harbour. There he gets 530 years for one surface, and 265 years for both surfaces. The next case is where he immersed cast-iron in what he calls foul sea-water; it was close to the mouth of the Great Kingstown main sewer with a bottom of soft putrid mud, the iron being immersed in the same way; the result of that is that it would take 586 years to eat through an iron plate one inch thick acting upon one surface, and 253 years to eat through it acting on both surfaces. He (Mr. Hawkshaw) having taken some pains to inform himself, has no doubt at all that a structure on Mr. Page's plan will endure for a long period of time. Assumes that there would be as much corrosion in the Thames as there is in clear sea-water, and that it would act on both sides; but thinks he has assumed the case against the bridge. For instance, Mr. Page in the first place fills the interior of his piles with concrete, and the concrete which he makes is of such an excellent quality that it is almost too much to suppose that the water will come in contact with the iron so as to do any harm. The same thing applies to the plates to some extent, but there is a portion of the back of the plates which only come in contact with gravel; no doubt in the gravel the water would come to the back of the plate. He considers that in the decay of the iron casing, fresh casing or plates can easily be applied; the iron plates are an inch thick, with two or three ribs at back; under the upper flange there are one or two brackets besides: these plates are of considerable strength. He apprehends no danger from fracture by a violent blow to the plates, because they are not exposed to a blow; the only thing now exposed to a blow is the top of the pile. He proposes to keep the piles a foot or 18 inches shorter by having a permanent band of granite round the piers at that point which would always receive the blow of barges at low-water, and would protect the piles; it is quite easy, and would not affect Mr. Page's plan in any important degree. The plates could not be struck; a barge would strike the face of granite; and another advantage is, that it would keep the bearing-piles more under water, which would be better. He does not think the iron casing acts as a support to the superstructure, and certainly that it is not in the slightest degree necessary that it should be so. The interior of the pier, excluding the iron casing, is amply sufficient to carry three times the weight of the bridge. He looks upon the iron merely as a casing to protect the interior of the pier. He thinks that the granite slabs on the top of the iron casing perform the functions of iron plates. He would have made the granite slabs shorter, and then introduced another course of granite, so as to have a large surface of granite to resist the shock of boats. He thinks the iron casing should have been more entirely separated from the superstructure.——*Mr Stephenson*, on further consideration, concluded that if the structure were

Iron Piles or Casing (*continued*)—

carried out upon the piers, modified according to the statements which had been made before the Committee, it would be secure in strength so long as the iron remained undestroyed by the action of time or otherwise; and that the greatest inconvenience that can arise will be replacing the iron when it decays. This would be an easy operation at low-water mark if the casing were free from the piers.

Lateral Sections.—*Mr. Rendel* thinks that the works done in the effort to keep up Westminster-bridge, and the quantity of stone that has been thrown down in all parts of the bed of the river round its piers, will cause great difficulty when the new bridge comes to be built upon those portions of that site of the old bridge where the foundations are in common. If it were determined to carry this bridge on upon its present site and upon its present plan, modified by the piers being carried down to the London clay, would advise making two bridges side by side, and connecting them by the roadway instead of making one entire bridge.——*Mr. Stephenson* agreed in the statement which has been made, that so far as regards bearing the weight wholly detached from the iron and granite casing, the piers are amply sufficient to bear the weight. There was no actual underpinning in repairing the old piers, but the vacuities were filled up by material which the engineer thought would be sufficient to prevent further subsidence going on. Thinks that probably there would be more difficulty than Mr. Page contemplates in building the second half, but by no means thinks that there would be any insuperable obstacle. Additional expense might be incurred, in consequence of the foundations having been disturbed; but they have not been disturbed by any means to the extent he had supposed. He considered that the new bridge may with safety, and without partial settlement, be built in halves.——*Mr. Hawkshaw* stated that if the difficulties of the work were such as to require that the two halves of the bridge should be separate and independent of each other, he would say, do not construct a bridge in that manner at all; but he believes that the bridge may be constructed on the plan which is proposed, and when constructed, the piers will become one whole pier, and there will be no unequal settling which will have any material effect upon the bridge, as the piles would, he believes, bear many times the weight put upon them. He thought anyone who would well examine the plans of the old bridge will not be afraid of the difficulty of removing its foundations.

Scour of the River.—*Mr. Rendel* stated that the average rise of the bed of the river, for many miles, is about 6 inches to a mile; above London-bridge it is much more, and the effort of the river is to equalise the inclination of its bed. If a Thames embankment is carried out at any time, the scour will be so increased that the gravel cannot but go to a very great extent, particularly at the bridges; but doubts much, unless the river be unduly narrowed, whether the river will be able to deepen its bed below the natural surface of the clay, although there is a great increase in the quantity of tidal water passing up the river. The engineer has anticipated such deepening, by proposing to dredge out between the arches to the London clay. If the scour of the river does not remove the gravel, then the mass of concrete will break up. Cannot think that if the gravel which supports the concrete were scoured away, the concrete would be found in the same form. Believes that the river will fall to a considerably lower level, and that it will approximate to the level of the sea-water. It is found in several cases that the low water in the Thames, opposite the London Docks, is lower than the low water at Sheerness, and which is found to be the case also in many other tidal rivers; because the oscillation of the tidal wave is such that it will fall just as much lower than its mean level as it rises above it, unless there is some obstruction. Believed that the gravel upon the whole of this part of the bed of the Thames will be washed out; and is perfectly sure it will be so, if ever the Embankment be carried out. If the obstructions be removed, and the various bridges be allowed to take their chance, which ought to be done if the navigation be considered important, the bed of the Thames through London would be scoured down to the original bed of clay. At Westminster it would come down to 12 feet below the present low water, which is just the level of the clay.——*Mr. Simpson*: The extent of dredging below bridge of late years has been very considerable; some large shoals have been removed; and it is found about 2 miles

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Scour of the River (*continued*)—
higher up the river than Westminster, that the ebb tides have gone considerably lower. At the present time the ebb is frequently 3 ft. 6 in. lower than it was twenty-five years ago. The river will go on improving its bed if it be allowed to do so, and it should not be coerced at the various bridges that cross it. It should be allowed to do with its bed as it likes, and the bridges should be made perfectly independent of that operation. If the scour of the river does remove the gravel, then the mass of concrete will break up.——*Mr. Stephenson*: If embankments and piers were erected on the river, the same as at Chelsea, they would produce a freer run of the water, and the scouring property would be thereby much increased. The increased scour is not likely to remove the whole of the gravel bed.——*Mr. Hawkshaw*: So long as the cast-iron may be assumed to endure, a bridge built as this is proposed to be built would be fairly guarded against any reasonable scour which appears practicable in the Thames. No doubt it would be possible to permit the construction of such works in the Thames as would cut away the foundations from any bridge. There can be no limit to scour if works are permitted which would cause that scour. The old London-bridge, and the scour caused by the removal of that bridge, is an exceptional case, which is never likely to happen again to the same extent. The old London-bridge was really a dam or a weir across the river, It prevented the tide coming up, and prevented the water flowing away, and the removal of the bridge caused a very great change in the bed of the Thames. Cannot conceive of anything occurring which could produce an effect equal to that produced by the removal of old London-bridge; at all events, it would be the duty of the conservators of the river to disallow any such works as could produce anything like an effect equal to that. If the embankment of the Thames should take place, did not think it would have any effect upon the scour of the river at this particular part. The effect of embanking the Thames would be to make the bed of the river more equal, but not to cause an irregular scour. The river may be deepened in its bed considerably over its whole width at the new Westminster-bridge, without affecting the structure in the slightest possible degree. No such irregular and improper projections should be allowed to be built as would direct the current to any particular point, and there scour out a deep channel. Supposing that the river was quayed on each side, as has been talked of, did not think that the scour occasioned by such contraction would interfere at all with the bridge, as designed, because the contraction would be done, if carried out according to the line laid down by the commissioners, in such a manner that the current would be regular, much more so than it is now. There would not be any tendency to scour at particular places. The bed of the river would probably be a little deepened, but that would not effect the bridge in the slightest possible degree. ——*Mr. Fowler* agreed with Mr. Hawkshaw respecting the effects of increased scour of the river, and the importance of not allowing any irregular works to be erected that would so influence the current of the river as to cause a deep scour at any particular point. When the iron casing is destroyed by lapse of time, he would provide other plates. Long before that period, the bed of the river will be at a permanent level. Presuming that it scours out down to the clay, and that the plate is eaten into, there will be no concrete, but gravel, and it the water flows in and out, it would carry the gravel with it, and undermine the bridge. May begin to watch it in 150 or 200 years, and until that time no such accident from neglect need be apprehended.

Strength.—*Mr. Rendel* stated that his objection to the principle of construction of the foundation is much increased by the belief that the bed of the river will very much deepen. He could not draw any analogy between a foundation formed on piles, cut off in the London clay, and then covered by a strong grating of timber, such as there is in London-bridge; and a series of piles standing up in the way these do, because there is no uniform distribution of the weight to be carried. Supposing the difficulty to be overcome of making the iron casing below low-water, perfectly sound, the gravel will be liable to disturbance by the least settlement or the concussion of barges. He apprehended that there would be no certain uniformity of bearing. He did not think that the weight of the pier itself is thrown fairly upon its granite casing, and considers that it would have been better, supposing this principle to be acted upon, to have had an iron casing perfectly independent of the weight of the bridge, so that the weight should really have been carried solely by the wood piles; but by the principle the engineer has adopted, the weight of the bridge would be carried partly on the iron piles and partly on the wood piles. The iron piles act as bearing-piles as well as a casing. He would recommend that the stability of the piers be tested by loading pier No. 4 with a weight four times greater than could be brought upon it in the finished structure.——*Mr. Simpson* said that he had gone into the question of the strength of the bridge, as regards the arches and every other part, and he considers there is ample strength.——*Mr. Stephenson*, with respect to the construction of the piers, expressed his opinion that their strength is amply sufficient to bear the weight.——*Mr. Hawkshaw* considered that a pier of the kind proposed to to be adopted is quite sufficient to bear the weight of the structure to be put upon it, which is comparatively trifling to those weights which have been imposed by engineers on other structures. Did not think that the iron casing of the bridge supports the bridge in any important degree. The bridge is not carried on by the iron; it is not in the slightest degree necessary it should be so. That part of the pier excluding the iron is amply sufficient to carry three times the weight of that bridge. He looked upon the iron merely as a casing to protect the interior of the pier. The granite slabs on the top of the iron casing rest upon the piles and that iron casing. The engineer appears to have used those slabs rather in lieu of plates. In the Chelsea-bridge, for instance, he would have filled it up with a plate. For reasons which he did not demur to, he has, instead of putting an iron plate here, put a granite slab. He still looked upon it as only performing the function of the plate, namely, to keep the interior protected from the exterior, from the water. There will be some weight upon it, but there need not be. He was quite sure that the interior of that pier, irrespective of it, is quite sufficient to carry the weight. No doubt that would have given great facilities. Looking to the arrival of the period when you might have to replace the iron casing, it would have been desirable that it should have been more entirely separated from the superstructure. It is not necessary that the bridge should rest upon the outer shell. Did not apprehend any difficulty in driving these iron piles so correctly as to allow the plate to slip between them with an equal bearing. Mr. Page had done it very successfully already. They could be rendered watertight by caulking them with iron cement.——*Mr. Fowler* was of opinion that either the timber piles or the concrete would be fully adequate to sustain the weight of the superstructure: any unequal pressure would not therefore be practically of any consequence.

Screw or Driving Piles.—*Mr. Rendel*: The alteration which took place as between the screwing and the driving of the piles, had not any material effect upon the construction of the bridge.——*Mr. Stephenson*: It depends upon circumstances whether driving or screwing the piles is best. If possible to screw them would do so himself, but does not see any objection one way or the other. The screwed piles would not be stronger or better than the driven ones.——*Mr. Fowler*: The deviation is of no importance; it is perfectly immaterial how these piles have been got down. In all bearing piles engineers depend upon the resistance which the piles will make to a certain number of blows of a certain weight: that is the real test. Until the ground has been tested by actually driving the piles, the proper length for the piles cannot be determined. The number of blows given to each pile is important, rather than the depth to which they are driven.

Site.—*Mr. Stephenson* considered that whatever difficulties may exist as to the site are only such as can be readily overcome. ——*Mr. Rendel* would put the new bridge immediately upon the site of the old one.

Timber Piles.—*Mr. Rendel* would have cut the piles off down to the level of the clay.——*Mr. Stephenson* considered it essential that the pile should be cut off below low-water; they ought not to be allowed to get dry. Kept below low-water the timber would be imperishable.——*Mr. Hawkshaw*: Timber piles constantly immersed last for an immense period.

Wrought-Iron Ties.—*Mr. Stephenson*: The wrought-iron ties to the granite slabs would, to a great extent, be exempt from oxidation. If the heads required they could be easily repaired.

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FOUNDATIONS OF BRIDGES CONSTRUCTED WITHOUT THE USE OF COFFERDAMS.

Name and Date of Bridge.	Over the	Number of Arches.	Span.	Total Length of Bridge.	CONSTRUCTION OF THE BRIDGE.
			ft. in.	feet.	
Alma Bridge, Paris. (1855)..... [Built by M. M. Michal, under the direction of the Engineer-in-Chief of the Ponts et Chaussées, and finished in the space of five months.]	Seine	3	141 0	470	– – The arches and piers are built of rubble grouted; the piers are founded on piles driven into and standing above the bed of the river, and distributed over the whole area. The space between the piles is filled in with concrete and rough stones, the whole is inclosed by wooden sheet piling, and protected from the scour of the river by rough stones.
Saumur Bridge ..... (Commenced 1756; finished 1770) [It is now standing, and has been subject to all those extraordinary floods of the Loire which have caused such ruin in its districts.]	Loire	12	66 0	1060	– – The arches and piers are of stone. The foundations for the piers were formed by driving piles distributed over the whole area, which piles were cut off by a machine below low water. The space between the piles was filled in with stones, and the whole pier was encased by a row of close piling, which was protected from the scour of the river by fascines and stones kept in place by an external row of piles. The piers, built in water-tight caissons, are sunk on spot on the pile-heads.
Nevers Viaduct (1850)..... [Built under the direction of a Commission of Engineers, composed of M. Boucammont and others.]	Loire	7	138 0	1250	– – The arches are of iron, the piers of stone, founded on a bed of concrete reaching nearly up to the low-water line, and encased by sheet piling. The whole pier is protected outside from the scour of the river by means of concrete or rough stones.
Ladenburgh	Neckar	7	88 0		... Stone bridge, founded on piles as before, encased by sheet piling, and protected from the scour outside by rough stones.
Geneva	Rhone	5 arches on one side.	51 0		... Suspension truss bridge pier, founded on piles, driven and cut off above the bed of river, and below low water. The space between the piers is filled with concrete, and encased by sheet piling, protected by large stones.
Ponts de Peney	... ...	... ...	240 0		... A suspension bridge, founded on concrete above the bed of river, encased by sheet piling, and protected from the scour of the river by large stones.
Souillac ..... [Water very deep at low water.]	... ...	... ...	... ...		... The piers are of stone, founded on piles distributed over the whole area. The piles are cut off below low water, and stand above the bed of the river, a height about equal to the width of the pier. The space between the piles is filled with concrete, deposited through the water by means of sheets. The foundations are encased by sheet piling as before, with two extra rows of piling outside, the spaces being filled with concrete, and the whole of the foundations are protected from the scour of the river by means of loose stones.
Rouen	Seine	... ...	... ...		... Stone piers, founded on concrete, encased by sheet piling, and protected from the scour of the river by loose stones. The level of the concrete is considerably above the bed of the river. The piers were subjected to a severe test before being finished.
Wester Voort	Yssel	... ...	... ...		... The piers above low water consist of an outside iron casing backed with a wall of brickwork, 3 feet thick, the internal space being filled with concrete. The piers below low water consist of iron plates sunk into the ground, the earth then excavated, and the whole filled up with concrete.
Marienburg	A branch of the Vistula.	2 spans	380 0		... Tubular bridge, founded on stone piers, resting on foundations of piles, cut off below low water. The piers are encased by sheet piling, coming up to low water, and the piers between the heads of the piles and low water are filled up with concrete. The piers are protected externally by rough stones. The river was deepened, and the slopes protected by loose stones.
Dorschau ..... [M. Lenge, Engineer.]	Vistula	6 spans	397 0		... The foundations for the piers of this bridge are exactly similar in construction to those of the Marienburgh-bridge before described.
Austerlitz	... ...	... ...	... ...		... Stones piers founded on piles driven into bed of river, and cut off between the bed of river and low water, and encased by sheet piling, and protected externally by stones, and an internal row of piles.
Jena	Seine	... ...	... ...		... Piers are of stone, and exactly similar to the one before described.
Wronke (1845)	Warthe	6	60 0		... Stone and brick bridge. The piers are founded on piles cut off between the bed of river and low water; the space between piles is filled with concrete. The whole piers are encased by sheet piling, coming up to low water line, and the piers above the piles and below low water are filled in with rubble. The piers are protected externally by loose stone work.
Carrousel Bridge, Paris	Seine	... ..	... ...		... Stone piers founded below low water, entirely on concrete, resting on the bed of the river, and enclosed by wooden sheet piling coming up to low water, and tied across the top by means of iron ties. Depth of water at low water 11 feet. The pier is protected by loose stones thrown in round the timber sheet piling.
Lary, Plymouth	Lary	5 arches	100 0		... Iron arches and stone piers. The piers are founded on rows of piles driven in the bed of the river, and cut off below low water by means of divers and bells. The piers are encased by sheet piling, and the space between the pile-heads filled in with stone. The piers were then built in caissons on top of this foundation, and the bed of the river was protected from the scour by means of clay and concrete.
Old London Bridge ..... [The bridge was of very massive construction, and had several heavy buildings on it; it was commenced 1176, and finished 1209, and taken down in 1834, after having stood 625 years.]	Thames	20	... ...		... Stone arches and piers. The foundations for the piers consisted of three rows of piles driven around the external face of the pier and cut off at low water; the area of the piers up to low water was then filled in with stones; the piers were then built on the tops of the piles and stones. The piers were further protected externally by piles, enclosing an area which was filled in with rough stones.

THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

CHELTENHAM MEETING, AUGUST 1856.

(*Continued from p.* 339).

On the Polyhedron of Forces. By Mr. J. T. GRAVES.

If any number of forces, represented in number and magnitude by the faces of a polyhedron, and in direction perpendicular to those faces, act upon a point, they will keep it in equilibrium. The above is the proposition which is called by the writer "the Polyhedron of Forces." It has probably occurred to many that the well-known geometrical representation in magnitude and direction of a system of balanced forces acting upon a point by the sides of a closed polygon is so simple and complete that nothing needs to be noted beyond the polygon of forces. What is commonly called the parallelopipedon of forces—which is the elementary theorem in solid space analogous to the parallelogram of forces—represents by the diagonal of a parallelopipedon the resultant force, which balances the three forces represented by the areas. But there the separate forces are represented by lines. The writer was led more than ten years ago to the representation of forces by areas in making researches respecting complex numbers with a new imaginary symbol. He has mentioned the result here enunciated to several mathematicians, to whom it has appeared familiar, and who have believed that it must have been already published; but the writer has searched for it in collections of memoirs and works on statics, and has been unable to find it in print. He has, accordingly, been advised by a very learned scientific friend to occupy it, if it has not been already appropriated. With this view, he takes this opportunity of publishing it to the British Association.

Sir W. Hamilton briefly showed that this beautiful theorem could be very simply deduced by his method of Quaternions.

On a New Theorem in Combinations and a particular Class of Congruences. By Rev. H. M. JEFFERY.

I. If there be n things, of which p are of one sort, q of another, &c., the number of combinations of the n things taken k together is the coefficient of x^k in the expansion of

$$\frac{1-x^{p+1}}{1-x}, \quad \frac{1-x^{q+1}}{1-x}, \quad \frac{1-x^{r+1}}{1-x} \cdots$$

The corresponding theorem in permutations of which one case is known, has not been solved.

II. If p is a prime number, $1^m+2^m+3^m+\ldots\ldots+(p-1)^m$ is a multiple of p, unless $m = r(p-1)$, when the remainder, after the division by p, is $(p-1)$. If a, b, c, d, denote four of the series 1, 2, 3 .... $(p-1)$, $\Sigma(a^{p-1}) \equiv p-1 : \Sigma(a^{p-1}, b^{p-1}) \equiv 1$, $\Sigma(a^{p-1}, b^{p-1}, c^{p-1}) \equiv p-1 : \Sigma(a^{p-1}, b^{p-1}, c^{p-1}, d^{p-1}) \equiv 1$, the general theorem is guessed at,

$$\Sigma(a^{p-1}, b^{p-1}, c^{p+1} \ldots\ldots k^{p-1}) \equiv \pm 1.$$

On the Causes of Great Inundations. By T. DOBSON.

The author stated that the principal special causes tending to produce great inundations in a country are the inclination and the lithological character of the surface of the basins drained by the rivers of the country. When the subsoil of a river basin is composed chiefly of porous, and, therefore, permeable materials, as oolite, loose gravel, &c., the rain will be absorbed almost as fast as it falls, and will reach the river gradually, after returning to the surface, through springs. But where the subsoil is generally compact and impermeable, as clay, granite, &c., the rain will flow over the surface with more or less velocity, according to the greater or less inclination of the surface of the horizon. So far, therefore, as the geological character of a river basin is concerned, the tendency to inundation due to that basin will be measured by the difference between the areas of the permeable and of the impermeable superficial strata and by the inclination of the sides of the basin to the horizon. The general cause of great inundations in the countries forming the western seaboard of Europe is the eastwardly progressive motion of the cyclones, or revolving storms, of the North Atlantic Ocean. Starting from the Caribbean Sea and the Gulf of Mexico, and sweeping during a considerable portion of their early course along the warm surface of the gulf-stream, they collect the vapours so copiously generated in the southern latitudes, and finally precipitate them on the high lands and mountain chains of Europe. In general, several cyclones follow each other in rapid succession, so that the continued series at length saturate the earth, and floods and inundations ensue. The author then proceeded to a most interesting meteorological history of the great inundations in France, in October 1844, October 1846, and in May and June of the present year, to illustrate these remarks on the general principles which explain the causes of the great inundations of Western Europe.

On an Adjustable Top, which exhibits the Results of the Theory of Rotation. By JAMES C. MAXWELL, B.A., F.R.S.E., and Fellow of Trinity College, Cambridge.

The deduction of the laws of the rotation of a rigid body from the elementary laws of motion has occupied the attention of many mathematicians, and the results obtained by Euler, Poinsôt, and others, have become a recognised part of mechanical science. There is, however, great difficulty in realising the conceptions of the composition of rotations, and of the motion of the instantaneous axis, and there is a great want of illustrative apparatus, which might exhibit every case as it is given by the theory. The theory of precession, and of partially-constrained motion has been illustrated by several instruments, of which M. Foucault's gyroscope is the most perfect. We still want something less delicate and expensive, and more at our command, to exhibit free motion about a point. The instrument here described was constituted for the use of students of dynamics, and exhibits the motion of a rigid body about a fixed point. The rigid body consists of a thick wooden ring seven inches in diameter, surmounted by a hollow cone. An iron nut is fixed into the cone at the vertex, and an iron screw, eight inches long, works in this nut and forms the axle of the instrument. The lower extremity of this axle is of hard steel, and has a fine but strong point, which rests in an agate cup fixed to the support of the instrument. This part of the instrument may be understood by reference to Mr. Elliot's paper, read before the Royal Scottish Society of Arts, 1855,* as this instrument is simply a modification of Mr. Elliot's top, by which its dynamic properties may be varied at pleasure.

The adjustments consist of six iron screws, with heavy heads, which work horizontally in the wooden ring. These are intended to regulate the position of the centre of gravity so as to make it coincide with the axis of the instrument, and to alter the moments of inertia about the principal axes of the rigid body. There are also three screws working vertically in the ring by which the principal axis of the central ellipsoid is made to coincide with the axle of the instrument, and a heavy bob working on the axle, by which the central ellipsoid is made oblate or prolate at pleasure. Theoretically, there need only be nine adjustments—three in order to regulate the position of centre of gravity; three for the magnitude of the axes of the central ellipsoid, and three to adjust their position in the body. Two others are introduced to save time in working the screws, so that there are eleven in all.

If the centre of gravity be made to coincide with the point of support, and the top be spun, we shall have one of the cases given by theory; but in observing the motion we have no means of observing the changes of position of the *instantaneous axis within the body.* There is, therefore, attached to the axle near its upper extremity, a disc of card, on which are painted concentric rings. Each of these rings is divided into four quadrants, painted red, yellow, green, and blue. On looking at this disc when in motion, we see that although the centre of the disc is moving rapidly the disc is really turning about some point not the centre, and the position of that point is known by its colour, and by certain marks on the rings so devised that they are visible during the rotation. In this way the path which the pole of the instantaneous axis traces on the disc may be ascertained and compared with theory. The form of this path is in general a conic section. When the axis of rotation is the axis of greatest or least moment of inertia it is an ellipse. When it is the mean axis the path is hyperbolic, and the motion is soon destroyed. When the axis of rotation is that of greatest moment of inertia the order of colours is in the direction of rotation, and by the number of revolutions of the top during one revolution of the instantaneous axis, the relation of the axes may be found. When the axis of rotation is that of least moment, the direction of motion of the instantaneous

* See *Journal, ante* p. 60.

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axis among the colours is reversed, that is, if the rotation of the top be in the direction of the hands of a watch, the order of succession of colours will be in the reverse direction. When the other axes are unequal, the path is elliptic, and its major axis is in the direction of the mean axis. When the principal axis does not coincide with the axle of the top, the path of the instantaneous axis has its centre on one side of the axle, and the error is rectified by adjusting the vertical screws according to this rule:—Set the top spinning about its axle, and steady it by touching the end of the axle, and observe the colour of the instantaneous axis when it begins to deviate from the axle. Then stop the top, and note the position of the colour observed, raise the vertical screws which are in front of it, and depress those behind it. This will tend to bring the principal axis nearer to the iron axle.

Besides illustrating the motion of a body round its centre of gravity, this top may be made to show the principles of the precession of the equinoxes. For this purpose it must be adjusted carefully, and then the point of support must be raised above the centre of gravity. If the axis be now inclined to the vertical it will move steadily round so as to describe a cone about the vertical direction in a direction opposite to that of rotation. This experiment, however, is much more successful when tried with a top whose central ellipsoid is very oblate, as is the case with that constructed by Mr. Elliot.

Machine for Polishing Specula for Reflecting Telescopes to a Parabolic Figure, and for Polishing Achromatic Lenses. By Richard Greene, M.D.

"The polishing machine, the model of which is brought before the British Association, scarcely deserves the name of an invention, inasmuch as the public have for some years been in possession of a very beautiful machine invented by Mr. William Lassell, of Liverpool, and most ably constructed by Mr. Nasmyth, of Patricroft Foundry. Some persons, acquainted with the superior specula produced by both these gentlemen as polished by that machine, will ask, why introduce an imitation or piracy of that invention? This question is solved by the weighty argument of *£ s. d.* Mr. Lassell's polishing machine is constructed entirely of metal, it weighs at least 4 cwt., is beyond the power of any amateur to construct, requires to be bolted to a wall, and takes many times as much power to work it as the simple and light machine of which you see a working model.

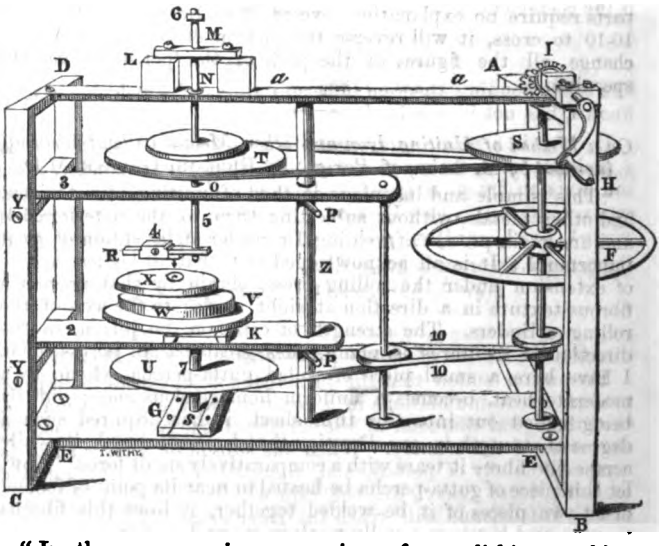
"The cost of the iron machine, from the great accuracy required in its construction, is, for the smallest size, I believe, 70*l*., while one on the principle of this model can be made by any handy amateur for less than seventy shillings.

"The only machine I ever made on this principle is amply powerful for a speculum of 12 or 14 inches aperture, its fly-wheel is under fifty pounds weight, all the bearings are in boxwood, which is far better than bell-metal, as they scarcely ever wear out, and require very little oil, never heating.

"In Mr. Lassell's machine the axis of the table which carries the speculum is in the same line with the axis of the slow crank, which is the first or prime mover, and by two systems of gearing rotating round a fixed toothed-wheel, the pin of the quick crank carries the polisher with an epicycloidal motion over the surface of the speculum. My machine effects this by a simple crank rotating in a circle, but the centre of that circle is capable of being removed more or less distant from the centre of the table which carries the speculum. This simple sliding of the axis of the table out of the line of the axis of the working crank, causes the centre of the polisher to describe over the face of the speculum the exact figure which the more complex machine produces.

"When I first contemplated the construction of a polishing machine on this simple principle, I did not intend it to do more than imitate exactly the motions which produced such good results in the hands of its inventor. In carrying out my design, however, it was obvious that by adding three or four more pulleys, the machine was (in addition to the proved movements of Mr. Lassell) invested with a power of enabling an experimenter in that most interesting branch of practical science to try the effect of a vast variety of motions in producing a fine figure on the surface of a speculum. I will here exhibit some beautiful and very dissimilar curves drawn by the machine itself, by substituting for the box which carries the point or pin moving the polisher, a wooden box carrying a black-lead pencil which traces its path on a piece of paper fastened down to the table by a weight on each corner.

"Several specula of 8½ 7, and 4½ inches diameter, have been polished and repolished with this machine, and in no instance has what may be called a bad figure been the result. One of its advantages is, that if the fault of a speculum be ascertained to be either a decidedly hyperbolical or spherical error, the former can with certainty be corrected by diminishing the eccentricity, and the latter by increasing the eccentricity of the table. It, however, often happens that the different zones of a speculum have their foci coincident when tried with diaphragms, yet from some irregularity of surface the speculum does not perform well. In these cases I have derived great advantage by placing the centre of the speculum a little eccentric from the axis of the table, so that in working the actual eccentricity will be sometimes the *sum* and sometimes only the *difference* of the two eccentricities, the mean eccentricity remaining unchanged. Mr. Lassell recommends a polisher of two pieces of light wood glued and screwed together with their grain at right angles. In his hands it has performed well, but as it is liable to warp with changes in the hygrometric state of the atmosphere, it is as well totally to prevent changes in the polisher by employing three pieces of board in place of two; the centre one being twice the thickness of the outside pieces, and the latter having their grain parallel to each other and at right angles to the centre piece. In covering the polisher with pitch it should be spread of uniform thickness, and it is necessary that the grooves or furrows dividing its surface into squares should remain open during the entire process of polishing. The method of dividing into squares recommended by Mr. Lassell, is by far the best with which I am acquainted. In forming the grooves by pressure upon the pitch, the portion of pitch pressed out of the furrows is heaped upon the edges of the squares, leaving a hollow in the centre of each square. The greater part of this elevation will be forced back again into the grooves, and fill them up. I find small squares of thin wood glued or stuck with pitch upon the face of the polisher previously turned to its proper curvature, answer extremely well. The polisher being held with the squares downwards is easily charged with pitch, and when quite cold, repeating the operation until a proper thickness be obtained.



"In the accompanying engraving of a polishing machine suited to polish specula of twelve inches diameter, and all sizes under, A B, is a square frame 2 feet inside measure made of scantling 2½ inches by 1½, firmly morticed and glued; C D, a parallelogram of the same scantling, jointed in the same manner, 2 feet high and 1 foot wide. E E, the bottom, 9 inches wide, 1½ inch thick, and 3 feet long. It is dove-tailed into the lower bars of the end pieces into half their thickness, and fixed by four screws for the convenience of taking the machine asunder. There is a top piece, *a a*, of the same length and thickness, only 4 inches wide, and fastened in the same manner to the top of the two frames. K 2 is a piece of well-seasoned hard wood 20 inches long, 7 wide, and 1½ thick, dovetailed and glued into piece Y 2, that will just fit inside the upright frame, and is kept in its

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place by two screws, one of which, Y, is seen; O 3 is a piece nearly similar, only 2 inches longer and 2 inches narrower. Each of these pieces is further supported by the cylindrical rod Z, which is 1½ inch in diameter, passing through them, and which has a pivot at each end which enters into the top and bottom of the machine near its centre. There are two strong pins, P P, on which the two boards rest. The axis, 5-6, of the working crank R, passes through a hole N, in the top board *a a*, without touching it, and moves in a piece of boxwood M, supported on two blocks of wood L, which gives it greater steadiness than if it were shorter, and is as good as making the whole machine as high as M. The journals of this axis are made very long, to permit it to slide up and down to allow the polisher and speculum to be taken off the machine in a moment when required. It is now shown as pushed up; when working it rests on a ring screwed on at the top, 6, which presses on the box-plate, M. The crank, R, is screwed on the end of the axis, and carries a sliding box, 4, which has a small steel pin on its under side, and fitting into a hole, X, in the top of the polisher; this box is kept to any distance from the centre of the axis by the pressure of a screw in its side pinching the crank; this is the quick or principal working crank. Part of an upright mandril, 7-8, is seen, on the top of which is screwed a strong iron chuck, V, a little larger than the speculum to be polished, and if a large one it should be ¾-inch thick in the middle; the mandril should be 8 inches long, and 1¼ thick at its upper end, which works in a slide of boxwood, the end of which is seen at K. The board to which the slide is fixed has a hole in its centre, a little larger than the mandril, and has a slit of the same breadth cut in it for 3 inches to allow the mandril to be placed eccentric to the axis of the working crank at pleasure; this is the essential principle of the machine. The tail of the mandril, 8, rests on a similar slide G, which must be moved as much as the upper one.

"The machine is worked by bevel gear, increasing the velocity as 3 : 2, the fly-wheel F is 22 inches, weighing 45 lb. The wheels S and T are similar, each being 12 inches, with a lesser one of 8 inches attached; the lesser one on T is uppermost, and on S the reverse, so that in a moment the velocity can be more than doubled by merely changing the position of the band. The wheel V is of 12 inches diameter; W is the speculum. The other parts require no explanation, except that by making the band 10–10 to cross, it will reverse the motion of the chuck V, and change all the figures of the path of the polisher over the speculum."

On a Method of Uniting Iron and other Metals without Welding, invented by M. Sisco, *of Paris.* By Richard Greene, M.D.

"This simple and ingenious method of uniting iron to iron, and other metals, without subjecting them to the deteriorating and uncertain process of welding, I consider an invention of great importance. It is an acknowledged fact, that all bodies capable of extension under the rolling press, obtain by that process a fibrous texture in a direction at right angles to the axis of the rolling cylinders. The strength of common hoop-iron, in the direction of its fibres, is many times greater than across them. I have here a small piece of rolled gutta-percha, which, by a moderate heat, becomes a uniform homogeneous mass; but, by being rolled out into this thin sheet, it has acquired such a degree of strength in one direction that I cannot break it, while across the fibres it tears with a comparatively small force. Now, let this piece of gutta-percha be heated to near its point of fusion, or let two pieces of it be welded together, it loses this fibrous texture, and becomes equally weak in every direction.

"Iron possesses this property in a remarkable degree, and it is as effectually destroyed by a welding heat The object of Sieur Sisco is to preserve the fibrous texture of the iron *uninjured*, and to unite the different pieces effectually. I have here a piece of a bar of iron composed of ten strips of ribbon-iron; it was broken off a long bar formed by this new process, and shows, firstly, that in no part has the uniting process given way; 2, in no part has the fibrous texture of the iron been injured; 3, that the fibres have actually been torn laterally out of the ribbons for more than two inches in length. I have here another piece of the same bar, which has been drawn out cold by the hammer to a smaller size without the ribbons being separated in any part.

"I shall now lay before you one of the most beautiful and important applications of this principle—the formation of chain-cables. The chain which I now exhibit was proved in the Arsenal, Woolwich, in presence of many scientific and professional gentlemen, in October 1851. It was coupled to various chains of the ordinary construction, and of greater weight per fathom than itself, all of which it broke in succession. The obvious object of the trial being to break this chain, it was finally coupled to a monster chain made of 3-inch iron. The hydraulic press was now gradually loaded up to 120 tons, when the framework of the press showing signs of giving way, the experiment was discontinued. The effect produced on the link tried was as follows: With 70 tons, it stretched $\frac{1}{16}$-inch; with 80 tons, $\frac{1}{8}$-inch; with 100 tons, $\frac{5}{16}$-inch; with 115 tons, $\frac{3}{8}$-inch; and with 120 tons there was no sign of weakness, or transverse fracture of a single turn of the ribbon; there was only a longitudinal separation of one of the bands at one side of the link, which did not weaken it.

"The weight of this chain, compared with an equal *length* of the best welded chain of equal *strength*, is in the ratio of 33 : 47, or little more than two-thirds. From the nature of the process of manufacture, and the impossibility of failure in uniting the joints, or of injuring the texture of the iron (as frequently happens in welding) if the entire chain be made of one quality of iron, it is necessary to prove only one *link* to ascertain the strength of the chain. This is a very great advantage, for it has been found that in chains which have been strained until one link has given way, and been replaced by a new one, other links have given way with a smaller force than what they stood on the first trial. From the difficulty of effecting a good welded joint, it is found that in proving the chains, seven failures out of ten occur in the joint; and when the heat has been sufficient to ensure a good welding, the fibrous texture of the iron has been destroyed. Another advantage of the Sisco chain is its *economy* in price. It is dearer than the common chain in the ratio of 124 : 98; but the weights of chains of equal strength are in the ratio of 33 : 47, so that the cost of a cable of equal length and strength stands thus: Sisco chain, 4092; common chain, 4606. This effects a saving in the first cost, besides the advantage of lightness in handling. The same principle of uniting iron has been applied to tubing of all sorts where great strength is required, as gun-barrels and cannon; these have been tried in Paris with perfect success; also to anchors, axle-trees, straps for blocks, and round chains for the running rigging of ships, the latter being made of coils of wire.

"To effect this intimate union, the iron is employed in the state in which it comes out of the rolling cylinders, covered with a thin coat of black oxide. The different pieces are pressed together as closely as can be effected, and held in their place by binding wire for small objects, and thin rod-iron for larger. They are next pickled in an acid bath, washed clean, and dipped into a boiling solution of borax in water; and, lastly, passed through a bath of an alloy of different metals kept in fusion in a reverberatory furnace, which completes the process. Various alloys may be employed for this purpose. Every variety of brass (except it contains much lead) answers admirably for the brazing; but for economy and strength Sieur Sisco recommends 100 parts of very fine soft cast-iron, 33 of copper, and 16 of oxide of manganese.

"The links of the chain are formed with great rapidity, by winding the ribbon-iron on an elliptical former turned by a toothed wheel attached to it, the former having a circular hole in its centre; the entire former and wheel together are cut in two in the direction of the major axis of the ellipse, then hinged at one end, and fastened with a pin at the other end of the ellipse, so as to open and shut at pleasure, and made to turn on an iron spindle fitting the round hole. The band of ribbon-iron (previously cut to the proper length) having a small piece about ½-inch of its end turned up with a hammer, is slipped under the pin which holds the two pieces of the mould together, and being pressed on by a lever to which a weight is attached, the mould is made to turn round the spindle by the action of a pinion, until the entire piece of ribbon-iron is wound on it, when the ends of the ribbon are secured in their place by binding wire, and the link is ready for brazing. The pin is now taken out of the mould, and the link taken off the former or mould, and put into the round hole in the mould, which is closed upon it and fastened by the pin. The mould is now ready to form another link round the link previously formed, by putting it again upon the axis, which has a piece cut out of its lower surface to allow the end of the first link to enter it, and it hangs down during the time the former is being turned to make the second link, and so on in succession."

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A New Route to India—The Syro-Arabian Railway.

By Mr. J. Locke.

This paper suggested a railway from Acre to Busrah, passing the Jordan between the 32nd° and 33rd° of latitude; to be continued from Busrah along the southern shore of the Persian Gulf, and crossing the northern spur of the Arabian Peninsula to Sohar, proceed coastwise to Maskat, and thence to Bombay. The gain in space of this line over the projected Euphratean routes was stated to be 400 miles, and in time (making due allowance for greater velocity of locomotive than steamer) two days and a half;—and over the present overland route, of 1000 miles, or six days, which might be increased one day and a half by accelerating the speed in the long level reaches of the Desert, where the traveller can observe at the distance of several miles any object of a size likely to impede or endanger a train. Mr. Locke's paper went on to demonstrate the shortness, security, and economy (both in time and cost of construction) of this route. He also pointed out the facilities likely to be afforded by the Ottoman government and the Imaum of Maskat, and especially dwelt on the collateral advantages of developing new markets and commercial relations, not only with Malaysia and the less known Oriental Archipelagos, but also with the eleven millions of the Arabian Peninsula, hitherto almost isolated from the conditions of modern civilisation.

REPORT OF THE LOCAL BOARD OF HEALTH UPON THE SEWERAGE OF DERBY.

By T. C. Thorburn, Borough Engineer and Surveyor.

The surveyor reports, that after a careful enquiry into the state and condition of the numerous old "dry brick" sewers in the streets and places within the Borough, he finds many of them are nearly half choked up in their sectional area with the solid part of the sewage, together with the sediment comprised of drift and detritus from the roads; and that few, if any, have less than from 2 to 6 inches of such deposit along the greater part of their entire length.

A register of drains laid by persons into the common sewers has been kept since May 1854. When a house drain is about to be connected advantage is taken to ascertain the size, description, and state of the common sewers into which such drains are about to be laid. The information obtained on these occasions is recorded.

Some of the sewers are, from their being constructed of brick laid dry without mortar, unsuitable to effectually carry off for a number of years together all the sewage discharged into them, but which are, from the comparative short time they have been used, still pretty free from deposit, and therefore may not require replacing for several years.

Since the introduction of water-closets, many have been put up in districts drained by the old permeable or "dry brick" sewers. The sewage from such water-closets has much contributed to, and increased the quantity, of deposit in this description of sewers; latterly, however, the Nuisance and Registration Committee have thought it inexpedient to order the construction of water-closets in districts where the sewers are not impermeable, or water-tight, and therefore not properly adapted for effectually carrying off into the main arterial sewers both the solid and fluid parts of the sewage, the old "dry brick" sewers being constructed and intended to carry away the sewage before the introduction of water-closets, such as the slops from kitchens and surface drainage, or rain water from the yards of dwelling-houses, stables, and roads.

Several of the old sewers are situate at a higher level than the floors of many of the cellars on each side of the streets, and where this is the case the floors of such cellars are frequently covered with water, and the fluid part of the sewage in a state more or less offensive according to the peculiar circumstances of each case, varying from a depth of one inch to a foot, such liquid sewage having oozed through the bottoms and sides of the said sewers. This state of things can only be accounted for by the manner in which these old sewers are constructed, *i.e.*, the bricks are laid dry without mortar or cement; this mode of construction facilitates their acting like sieves, by allowing the water to percolate between the joints of the bricks, leaving the solid parts of the sewage to settle and deposit, and become a hard sediment along the invert, which for want of sufficient water to carry it off in suspension becomes in time immoveable by the ordinary flow of water usually carried off by this class of sewers, gradually accumulating until after a period of more or less duration, according to the sectional area of the sewer, the watercourse in consequence becomes entirely choked up, and the water merely soaks instead of running through such culverts, ultimately involving serious expense, not to say inconvenience, by the breaking up of the streets and cleaning out the sewers by hand labour.

Within this borough, it may, in course of time (so as fully to attain the object of town sewerage, as now recognised by the best authorities, viz.—immediate and safe removal of all surface waters, and also of all soil, excrementitious matter, and slop refuse from houses, to such outlets as shall be the least means of nuisance to the inhabitants), be found desirable to abolish as far as possible all sewers constructed so as to admit of the percolation of the fluid part of the sewage into the ground adjoining, more particularly where the subsoil is of a porous nature; as such percolations cause much injury and serious pollution to the neighbouring wells drawing their supply from what are generally known as "land springs," which at best in large towns are but seldom pure, and often doubtfully wholesome.

The surveyor appends a list of streets and places where new and improved sewerage is most required, with a view to the suggested sewers being constructed as opportunity offers. The proposed new sewers can conveniently be separated into groups according to the drainage districts, the worst conditioned being taken first, and the works in each district being contracted for separately by public tender obtained in the usual way, as well as for the construction and completely finishing of and the keeping in repair after completion for a term—say for not less than twelve months. The estimate provides for a junction to be inserted in the common sewers for all existing house drains, together with their connection, and includes side entrances, manholes or examining shafts (with flushing sluices) flushing tanks or cisterns placed where requisite, constructed under the street surface level, and new gulley connecting drains.

When the plans and sections of the proposed new works are completed, separate detail estimates will be furnished as each group are about being tendered for. In the appended estimates provision has been made throughout for the greatest depth that will be required, and the proposed sewer levels arranged, not only in the streets in which they will be placed, but also (where necessary) to outlying land which may yet be built upon. The general arrangements shall be such as to admit of any extension for future requirements; and the principles necessary to a proper system of sewerage, and which are applicable to the construction of sewers generally, will in the construction of any of the proposed sewers be carefully attended to.

Principle of Construction of Sewers.

Mr. Thorburn proceeds to point out the principles upon which sewers should be constructed to render them self-cleansing, and adapted to efficiently carry off all sewage, and also the mode of ventilation.

1. That the line for each new sewer be the shortest and most direct route along the centre of the streets to be drained, avoiding all unnecessary angles, and if at all suitable, in the same line as the existing sewer to be substituted, with the outfall and level arranged (so far as the district outlet sewers already constructed will admit) as to secure the effectual under drainage of all the houses and buildings on either side of its course and admit of the private branch drains being laid at such rates of inclination as to secure rapid flow through them of all water, sewage, &c., emptied into their inlets.

2. That the rates of inclination of each new sewer be such (wherever practicable) as will prevent any deposit from taking place within it, and consequently avoiding, to a considerable extent, the evils of allowing decomposition to take place in the sewers; and as a further precaution, and means of a regular test of their state at fixed periods of time (say once a month) artificial contrivances be resorted to and provided where natural facilities cannot be obtained, by admitting a great body of water at the highest level, to flush each entire line of sewer.

3. That the form of the new sewer be that which will afford the greatest amount of resistance to the external pressure of the soil in which it is placed, and the least amount of resistance to the flow of water within it, and at the same time that which requires the least quantity of materials in their construction, and of such a size as to be sufficient in capacity to carry off at all times the sewage water, surface draining, and land springs; and be generally increased in size from that given to the upper end

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at the junction of the principal branch sewers and drains, sufficient for the purposes, without such excess of capacity as would retard the current passing through them.

4. That the new sewers be constructed of such materials as will admit of all the old bricks suitable being re-worked into the new structure, and at the same time present the smoothest possible surface for the passage of the water, and prevent any of the liquid within them from percolating through into the subsoil; enduring in their character and not liable to require re-construction in the course of a generation, and that all junctions with the new sewers be made with curves of as large radii as possible in the direction of the current.

5. That all inlets of such junction sewers or drains be effectually trapped, and that a through system of ventilation be, as far as at present attainable, effected by the connecting all vertical house rain-water conductors discharging the water at present on the foot-paths; and also, as recommended by Mr. Nasmyth, of Manchester, where convenient and permission is given, the space below the fire-grates of manufactories, and other furnaces, by suitable tunnels or air passages, which will exhaust the sewers of their foul air, and deprive it by means of the burning coal in such fires of pestiferous qualities so dangerous to health.

A suggestion is also made by Mr. Handyside, engineer, that the sewers be connected with the retorts at the Gas Works, which, if permitted, would, from their number, effectually draw all the foul air out of the whole system situate within the northern and western drainage districts.

Flushing of Sewers.

The report recommends that, in laying down any of the proposed new collateral street sewers, they all be arranged as to lines, levels, and junctions, connected one with another, so that with a cistern or tank filled with water at six or eight given points at the highest ends of the sewers, the whole may at pleasure be flushed at comparatively little cost, the water for this purpose being charged for at a reasonable rate by the Water-works Company.

The flushing may then be carried through one collateral line after another, by placing at the upper end or junction of a sub or lateral sewer, with the line at which the cistern is situate, hand penstock gates, that can be lifted up through an ordinary hydrant or stopcock box, fixed level with the surface of the street, and over the handle of the gate.

Great advantage and convenience would accrue, and considerable expense would be saved, if this arrangement was in course of time extended generally to all the new sewers, more especially to those that have little fall, and are constructed without any provision for flushing, several of which already contain from two to twelve inches of sediment firmly deposited at the bottom. This is owing, no doubt, to the small quantity of water regularly running through them.

Disposal of the Sewage.

The application of town refuse, either fluid or precipitated and in the solid form, is now engaging the attention of companies and of private individuals; but as yet it is unquestionable that whatever its commercial value may be, hitherto no works on a large scale have been successful, despite the numerous places where the application of sewer water has produced beneficial results, as for instance at Edinburgh and Milan. Experiments are in progress at Cardiff Gaol, under Mr. Higgs, and also at Leicester, under the superintendence of Mr. Wicksteed, C.E. Mr. Yarrow, C.E., has also a process by which he produces very valuable manure from sewage. The great difficulty appears to be in securing in a permanent form the ammoniacal salts. The use of lime-water causes the precipitation of organic matter, but it appears that something else of a sufficiently preponderating affinity between the lime and the carbonic acid gas, to cause the latter to quit its combination with the ammonia to join the lime, is required.

Mr. Stothart professes to accomplish this by the use of sulphate of alumina, and some time since an opportunity was given of witnessing his mode of operating upon the sewage derived from the Northumberland-street sewer, London, which, as an experiment, was generally considered eminently satisfactory, the water being delivered, after undergoing the process, clear as crystal. How far the result of its application on a large scale may justify his expectations it is difficult to say.

REGISTER OF NEW PATENTS.

PUDDLING AND REFINING IRON.

G. Parry, Ebbw Vale Iron Works, Monmouth, *Patentee*, February 26, 1856.

This invention relates to the subjecting of iron while in a molten state to the action of the elements of water, for the purpose of disengaging the sulphur and other volatilisable impurities therefrom. For this purpose, instead of using steam (as at present), which, by its comparatively low temperature, chills the metal at the points of injection, and thus produces but a feeble action upon the surrounding or contact surfaces, the patentee superheats the steam prior to injecting it into the fluid metal, and by thus causing the steam to approach more nearly to the temperature of the molten metal, obtains a more efficient chemical action.

In the puddling of iron, according to this invention, fixed tuyeres are used for the injection of the heated steam into the molten iron, such tuyeres having therein orifices above the surface of the molten metal. The tuyeres project through the sides of the puddling furnace, and when they are intended to direct jets of heated steam on to the surface of the metal they are inclined at an angle from the perpendicular. In practice, this angle will be found effective between thirty and fifty degrees; but about thirty-five degrees being preferred. The distance of the points of the tuyeres or jets above the surface of the molten iron will vary according to the pressure used; with the ordinary working pressure from two to four inches of elevation, or thereabouts, will answer best. The object in elevating the jet above the surface is to give the current of steam an additional dose of heat before it strikes the iron, by carrying down and mixing with it the highly heated atmosphere of the furnace, and thereby further increasing its action on the molten iron, for the higher the heat the greater the chemical action. The point of elevation must bear some proportion to the pressure used, or the steam will not reach the surface of the iron with sufficient force to produce a maximum effect; and this force must always be equal to depress the surface of the iron, and by reason of the inclination of the jets give it a gyratory motion around the furnace, thus bringing fresh surfaces of iron continually in contact with the jets of steam. For white and mottled iron, and bright grey iron, or No. 3, two tuyeres of iron tubing ¾-inch diameter are employed, one each side of the working door of the furnace; but for a more highly carburetted iron, a greater number is recommended, in order to obtain the most decisive effect. The points of the tuyeres are preserved from burning by occasionally arming them with a lump of soft fire-clay, through which a pricking rod is driven by first removing the plug at the other end of the tuyere, or water tuyeres may be used.

A puddling or reverberatory furnace is fitted with a coil of pipe for superheating the steam, and an arrangement of pipes for conveying the super-heated steam to the tuyeres. A cock is employed for turning on and regulating the supply of steam, which is obtained from any ordinary steam generator.

The mode of operating is as follows: The iron having been brought to a fluid state the steam cock is opened, and the puddler proceeds to work the iron with his rabble, as usual, with this exception, that at the period the metal begins to thicken by conversion into wrought-iron, a greater number of the strokes of the rabble must be given opposite the tuyeres than at other points of the furnace. When the process of boiling has so far progressed that the rabble can no longer be used, owing to the weight of wrought-iron made, the steam is cut off, and the "heat" of iron finished in the ordinary manner.

By this mode of working with two tuyeres, as described, the time usually occupied in boiling is reduced by about one-half, while the general character of the iron is much improved. If, however, a greater improvement in quality, irrespective of time, be the object in view, the process must be varied. The puddler, instead of using his rabble with the usual vigour, will leave the iron to be principally acted upon by the oxygen of the steam, the other element of which (hydrogen) in escaping carries off in a gaseous state most of the impurities contained in cast-iron, and more especially sulphur, phosphorus, and arsenic; but still the rabble must be used to some extent, in order to keep the iron free from the cold bottom of the furnace. When sufficient wrought-iron has been made to necessitate its removal by the "paddle," it is placed in the furnace as far as possible from the

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tuyeres, and the remaining fluid cast-iron still unconverted is brought under the action of the steam, and the converting process is continued till the whole of the metal has been "dried up," after which, during the time of welding or balling, a very gentle blast of steam only is kept on.

The jets of steam are also found to enhance in a remarkable degree the effect (upon the iron) of other substances which have hitherto been used in the puddling furnace, either with a view of increasing the yield or improving the quality of the iron. It is found that by using rich oxides of iron the amount of iron drawn is greater than the pig-iron charged, a result never obtained before the use of the jets of steam, and also that a greater improvement in quality has resulted by the use of oxides of manganese or mixed oxides of manganese and iron, such as spathose ores, than has hitherto been obtained by simply raking them up with the molten iron, and that the greatest effect is produced by adding those substances in about five minutes after the steam has been turned on.

With bad iron containing little carbon and large quantities of sulphur and phosphorus, and sometimes a large alloy of silicon, and which does not keep long boiling, but falls on the bottom of the furnace in a pasty and intractable mass, very considerable benefit has been found in yield, time, and quality, by subjecting this mass to the action of as strong a current of steam from the tuyeres as it would bear without reducing its temperature too low, the puddler in the meantime working it in the usual manner.

With superheated steam considerable advantage is gained by steaming the cinder left in the furnace, with the door partly open, after the heat of iron has been drawn. When water or cold damp steam is applied it quickly produces a pasty mass from refrigeration, with little or no chemical change, but with hot dry steam oxidation goes on rapidly, and the cinder, although kept at a high temperature, becomes solid and more difficult to fuse. A chemical change will also be found to have taken place in the combination of the oxide of iron with the silica by the peroxidation of the former as well as in the expulsion of part of the usual impurities before named; hence, a beneficial effect on the quality of the next charge of iron will accrue, as well as a greater stability in the sides and bottom of the furnace be obtained.

In the refining of pig-iron or converting it into what is known as refined metal, the patentee uses a reverberatory furnace, similar to the one described, only larger, and capable of containing one and a-half to two tons of molten-iron; but instead of a cold iron bottom, as in ordinary puddling furnaces, a fire-stone, fire-clay, or sand bottom is used. The tuyeres are arranged in the same manner as above, and are nine in number, viz.—two each side of the working door, and five at the back of the furnace at nearly equal distances. The heat of the furnace having been got up, the charge of iron is run in, and the steam turned on. The refiner soon with his rabble moves the iron in the vicinity of the tuyeres, and repeats this action occasionally, and, if necessary, in other parts of the furnace as the operation proceeds. When this has been sufficiently protracted, which may be known by a little practice, the furnace is tapped, and the refined iron run into moulds, as at present in use at the ordinary blast refineries. The "metal" made by this process from the decarburation of the iron, having been mainly effected by the oxygen of steam instead of that of atmospheric air, together with its freedom from contact with coke (which always contains sulphur), will be found to prove of greatly superior quality.

In the puddling and refining of iron, injecting the steam on the surface of the molten iron when in shallow depths has hitherto been spoken of. In the refining of iron, however, the process admits of a variation. For this purpose, the walls of the reverberatory furnace are made stronger than usual, leaving an oblong trough for the reception of the metal, two and a half feet wide, two feet deep, and four feet long, or thereabouts, being a convenient size. The bridge must also be well protected by passing a strong current of air through it. The orifice of the tuyeres is placed very near to the bottom of the furnace, so that the discharge of highly-heated steam may take place deep in the body of the metal, and bubble up through it. The furnace is furnished with an extra door on the opposite side for the convenience of renewing the points of the tuyeres, as before described. The depth of fluid iron to be acted upon should be 18 inches, or more, as a lesser column of metal will not be found so effective. After the heat of the furnace has been got up, the steam is turned on a few minutes previous to the charge being run in, in order to insure the perfect dryness of the steam previous to its contact with the fluid iron. The pressure of the jets of steam must, of course, exceed that of the column of metal acted upon, and the absolute quantity of steam passed through each tuyere in a given time must bear some relation to the height of the column of metal to be acted upon, it being so regulated that as little as possible of spare oxygen shall escape at the surface; any excess above this would tend to reduce the temperature of the mass of refined iron, and impair its fluidity. The iron having been sufficiently decarbonised is run into moulds as usual.

In the refining, by this process, of iron for subsequent conversion into steel, a reverberatory furnace is used capable of raising a very high temperature of the size of an ordinary puddling furnace, but supplied with a warm fire-stone, or sand bottom. With this furnace four steam tuyeres are employed, viz.—one on each side of the door and the other two at the back of the furnace. The furnace is charged with about four hundredweight of highly carburetted pig-iron, and when melted the steam is turned on, and allowed to act on the iron with the least possible use of the rabble. When the ebullition has proceeded to a sufficient extent, the furnace is tapped, and the metal run into water to granulate and partially oxidise it. This granulated iron, on refusion in crucibles with an admixture of the ordinary purifying agents now in use, will be found to produce a good cast-steel. If a superior article be desired, in about five minutes after the steam has been turned on about two per cent. of pipe-clay, or any clay rich in aluminium, in coarse powder, is thrown into the furnace, and soon afterwards from ten to fifteen per cent. (according to the degree of carburation of the iron used) of calcined spathose, iron ore, or sparry carbonate of iron, also in coarse powder, is added. By the action of the jets of steam the union of a portion of the metallic bases of these minerals with the iron is much facilitated, and a better description of refined iron obtained. It is important that if the white or crystallised spathic ore should be the kind used, it should be calcined in an oven at a very low red heat; if a high heat be employed, its power is much impaired for this purpose.

The patentee remarks that he does not confine himself to the one mode of heating the steam pointed out, but considers that the mixing of ordinary steam with highly-heated atmospheric air or other gaseous body, so as to superheat it prior to its contact with the fluid iron under the process of puddling or refining, would be an infringement of his invention.

Claim.—The employment in the puddling and refining of iron of superheated steam injected into the molten metal, in the manner and for the purpose above set forth.

MANUFACTURE OF IRON, COPPER, TIN, LEAD.

A. Pope, Edgware-road, *Patentee*, January 29, 1856.

This invention relates, first, to the manufacture of iron. The patentee takes one ton of hematite iron ore or other iron stone, as free as possible from sulphur, and melts it in a short blast furnace or cupola with anthracite coal or charcoal and carburetted anhydrous silicate of alumina (the residuum from the distillation of boghead or torbane coal or other bituminous shale); of this fuel 250 lb. is used, composed of two-thirds anthracite coal or charcoal and one-third boghead coke; the silica and alumina combines with the iron ore without reducing the iron to the metallic state. This is crushed to a coarse powder; then mixed with 200 lb. of boghead, broken to a coarse powder and placed in a reverberatory or air furnace, the temperature being then raised to bright redness, but not sufficient heat to melt the same, with a fuel as free as possible from sulphur; the heat is continued for two hours, stirring the mass at times; during the continuance of the before-mentioned heat, 2½ per cent. of spent oxide of manganese is added. The heat is now raised so as to produce complete fusion of the whole, and continued in that state thirty to forty minutes, during which time the bath must be stirred, so as to thoroughly mix the whole; the slag or scoria should be removed at intervals. The temperature is now either reduced so as to render the iron pasty for the manufacture of bars, or the whole charge is run into pigs for after manufacture.

A more highly carburetted or steely iron is made by following the same process as above, with from 250 to 300 lb. of boghead to the ton, and continue the first heat two and a half hours, and the second or melting heat, thirty to forty minutes. The iron so produced is still more highly carbonated, by following the same process and using a larger quantity of boghead, 400 lb. to

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the ton, and the first heat three hours, the second heat the same as before. The patentee takes white or forge pigs produced by the above-mentioned process, or ordinary forge white pigs, or pig-iron melted and chilled, so as to produce a white iron of a crystalline fracture, and mixes the same with ordinary pig-iron, from one-tenth to half of the white iron. One ton of the mixed irons is melted in a cupola, with a fuel composed of anthracite coal, or charcoal, or coke, free from sulphur, and boghead refuse, before mentioned; of this fuel 240 lb. is used, two-thirds anthracite, charcoal, or coke, and one-third boghead, to melt one ton. During the fusion 2½ per cent. is added of spent oxide of manganese and 10 lb. of limestone as a flux; this will produce an iron of greater strength than ordinary iron, and of a better colour, suitable for bright work. The proportions of the mixed metals before alluded to should be determined by the purpose for which the iron is required. Any of the iron so produced is used for the manufacture of wrought-iron or steel, either direct from the air furnace or by the ordinary process of puddling, using the before-named boghead or shale in the manufacture. The boghead is also used as a fuel for the melting of iron by the ordinary process, mixed either with anthracite, charcoal, or coke, in proportion from one-fourth to half boghead, according to what fuel be used.

Copper.—The patentee takes ore as is generally received for smelting; roasts the same, as is usually done in the manufacture of copper; the melted state is continued three hours; at the expiration of the second hour 70 lb. of iron scale, or oxide of iron, or iron slags, or other body containing a sufficient quantity of iron, is added to each ton of copper ore; the iron will combine with a large quantity of earthy matter and form a scoria or slag, which must be removed; after the scoria has been removed at the end of the third hour to the melted mat or bath, 200 lb. of oxide of iron or hematite iron ore is added, and 4 cwt. of the anhydrous silicate of alumina, or boghead refuse, or other carburetted shales, having a similar composition. The oxygen of the iron ore combines with the yet remaining sulphur, and drives it off in the form of sulphurous gases; the silicate of alumina combines with the iron and other impurities, reducing by the carbon contained any oxide of copper that may have been formed by the oxide of iron used; the mass should be agitated at times. A very fusible slag will be produced containing very little copper in the metallic state. The bath is allowed to be acted upon by the above-mentioned materials in a full melted state for four hours, when the slag being removed, metallic copper will remain. If the reduction should be found not complete, a second application of the boghead refuse and continuance of the heat will be necessary; samples should now be taken from time to time, so as to enable the workman to ascertain the progress of the reduction, which, when satisfactory, the slag should be removed, and the copper run into ingots, as is usual. Copper ores vary very considerably in quality, therefore the proportions must be varied to suit each ore, which proportion the workman must determine by experiment. The before-mentioned proportions are suitable for a sulphuret or ore of copper containing from 20 to 25 per cent. of copper; the fuel used on the grate of the furnace should be anthracite coal, or a fuel as free as possible from sulphur. One ton of roasted copper ore is melted in a short furnace or cupola with a low blast. As fuel, a mixture of anthracite coal or charcoal and carburetted anhydrous silicate of alumina, or other similar shale is used; of this fuel 200 lb., composed of two-thirds anthracite coal and one-third boghead refuse is employed. The ore is melted alternately in the furnace, 1 cwt. of ore, 10 lb. of mixed fuel. The patentee adds, and equally divides, 1 cwt. of hematite iron ore or oxide of iron to the charge; a large quantity of very fusible slag will be produced, which should be either tapped out at intervals, or allowed to run into a receptacle, where the slag can be separated from the metallic copper produced. This copper is refined in a reverberatory or air furnace, using for every cwt. of copper 2 lb. of oxide of iron and 10 lb. of boghead; samples must be taken to ascertain the state of the metal produced. Should the slags contain sufficient copper, they are crushed and mixed with boghead, in bulk equal to one-fourth of the broken slag. The slag is remelted in a common reverberatory furnace, and continued in a melted state two hours, agitating the mass at times. Samples are taken for the quality of the metal so produced, from which the workman will determine the extent of the operation.

Tin.—The patentee takes ordinary tin ore, as is usually received for smelting, and roasts the same, as is usually done, to expel arsenic or sulphur. The roasted ore is mixed with boghead refuse, or other similar body, in equal proportions, bulk for bulk, and the mixture submitted to a red heat in a reverberatory furnace for two hours, agitating at times; a quantity of slag will be formed consisting of earthy impurities and iron contained. The heat is now raised to whiteness, and continued one hour, not stirring the mass; the melted mass is tapped into a proper receptacle and allowed to cool; the slag is then separated from the metal. If found to contain sufficient metal the slags are crushed to a coarse powder, mixed in equal proportions with boghead refuse crushed to a coarse powder, the mixture being submitted to a full red heat for one and a-half hour; the metal, if any, will be reduced, and can be run into proper moulds.

Lead.—The patentee takes lead ore, as is usually received for smelting, and roasts it to expel arsenic. It is then mixed with two-thirds boghead refuse crushed, and the mixture submitted in a reverberatory furnace to a red heat until the reduction be judged to be completed; a slag will be produced containing earthy impurities and iron; the reduced metal can be run from the slags, as is usually done, leaving a portion of the slag for the commencement of the next charge.

Claim.—The use of boghead or torbane mineral after the distillation for gas or other purposes, or similar bituminous or carburetted shale, either as a fuel mixed with other fuel, or as a reducing agent, for the manufacture of metals generally requiring a red heat for their reduction or manufacture.

TREATING CAST-IRON.

C. M. T. du Motay and J. J. Fontaine, Paris, *Patentees*, March 1, 1856.

The object of this invention is to purify and decarbonise cast-iron simultaneously either in puddling or finery furnaces, so as to convert it into wrought-iron having the properties of steel, by the use of artificial fluxes or chemical agents, reacting either together or separately on the cast-iron during its reduction to the state of wrought-iron, without in any other way changing the ordinary puddling and refinery processes. The artificial fluxes may be prepared in either of the following modes:

First—By melting the scoria commonly employed in puddling and finery furnaces with silicate of alumina, obtained either from clays, feldspaths, refractory earths, or from marls, or any other silicates of alumina, combined with silicates of the alkalies, alkaline earths, or metallic oxides. Adding to this flux before or during its fusion, first, a bicarbonate of potass or soda; second, a silicate of the protoxide of iron or any other anhydrous silicate.

Second—By melting the scoria commonly employed in puddling and finery furnaces with a silicate of alumina, obtained either from clay, feldspaths, refractory earths, or from marls, or any other silicates of alumina, combined with the silicates of the alkalies, alkaline earths, or metallic oxides. The patentees refine or puddle cast-iron in this flux. During this refining or puddling, the oxides of iron produced unite with this flux, to which is added silicate of protoxide of iron, or any other anhydrous silicate. The artificial fluxes being constituted according to one of the two modes above described, are run out and allowed to cool. The puddling furnaces or refinery crucibles are then lined with the silicates and oxides of iron commonly employed for refining and puddling cast-iron.

With these silicates and oxides are melted either the first or second artificial flux. The cast-iron is refined or puddled in this flux. When the cast-iron is in part decarbonised, the patentees throw into the refining crucible or into the puddling furnace, either a hypochlorite of potass, of soda, of lime, of magnesia, or of strontia, or baryta, or a bicarbonate of potass or soda.

The basic carbonate of magnesia can also be employed. The salts above mentioned can be replaced with double salts, or by the following mixtures of salts and oxides, carbonates of iron and potass, carbonates of iron and soda, carbonates of iron and lime, carbonates of iron and magnesia, carbonates of manganese and potass, carbonates of manganese and soda, carbonates of manganese and lime, carbonates of manganese and magnesia, carbonates of potass and chloride of potassium, carbonates of soda and chloride of sodium, carbonates of lime and chloride of calcium, carbonates of magnesia and chloride of magnesium, carbonates of potass and chloride of sodium, carbonates of potass and chloride of calcium, carbonates of potass and chloride of magnesium, carbonates of soda and chloride of potassium, carbonates of soda and chloride of calcium, carbonates of soda and chloride of magnesium, carbonates of lime and chloride of potassium, carbonates of lime and chloride

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of sodium, carbonates of lime and chloride of magnesium, carbonates of magnesia and chloride of potassium, carbonates of magnesia and chloride of sodium, carbonates of magnesia and chloride of calcium (we mean by carbonates—carbonates, sesquicarbonates, and bicarbonates of the above-named alkalies); oxides of manganese, chloride of sodium, oxides of manganese, chloride of potassium, oxides of manganese, chloride of calcium, oxides of manganese, chloride of strontium, oxides of manganese and chloride of barium. The oxides of iron or chromium can be substituted for the oxides of manganese.

In the following operations, whether the chemical agents above mentioned are employed or not, the patentees continue to add to the flux, first, a small quantity of the first or second artificial flux; second, iron scales proceeding from the hammering and rolling of the blooms produced by this process.

According to the quality of the cast-iron to be reduced, a greater or less quantity of one or other of the artificial fluxes above mentioned, is added, or of the salts and oxides above mentioned. In general the quantity employed does not exceed five per cent. of the weight of the crude cast-iron treated. The hypochlorites, the bicarbonates, and the other salts and oxides above mentioned can be employed for the purification of cast-iron, without employing the two artificial fluxes before mentioned, especially if a certain quantity of silicate of protoxide of iron, or of any other anhydrous silicate is added to the scoria commonly employed for refining or puddling cast-iron.

The patentees begin by heating either the puddling furnaces or he refining furnaces to an orange heat, which temperature is tnecessary for the complete fusion of the metal to be reduced to the state of iron.

When the ore (or metal) is in a state of perfect liquefaction, the temperature of the puddling furnaces is lowered by closing the valve of the chimney, and when using refinery furnaces the lowering of the heat is effected by diminishing the rush of air through the tubes or tuyeres.

In proportion as the ore is decarburated and granulated, either one of the simple salts or one of the compound salts is thrown into it, or again, one of the mixtures of salts and oxides above described. When the metal, more and more refined and decarburated from its contact with the oxides and chemical agents above named, assumes the nature of iron at the surface of the bath, the temperature of the puddling furnaces or refining furnaces is again raised to a welding heat, in order to permit the puddling or refining workmen to form the balls.

This terminates the series of operations peculiar to the working of these processes, the subsequent operations of furnacing and shingling of the balls being the same as those heretofore practised.

METAL FOR SHIPBUILDING, STEAM BOILERS, AND BRIDGES.

C. F. Claus, Latchford, Chester, *Patentee*, Feb. 25, 1856.

This invention consists in the production of extended surfaces of metal by so uniting a number of bars or strips that they are interlaced or platted together. In order to obtain greater firmness, bars or strips are notched and so arranged that the projecting parts fit into corresponding recesses; and the lapping edges are rounded in order to gain a smooth face. The several portions are also welded, or tin and lead or such metals are used to solder the whole together. The metal plates thus formed may be applied to the construction of metal ships, bridges, gasometers, and other structures in which metal plates are rivetted together. The bars or strips of metal are interlaced or platted together, being first produced of a suitable length, and are rolled or formed by any ordinary arrangement of apparatus with notches on the edges, there being also recesses formed on the face of the same; and in order to obtain greater firmness and more perfect joints when platted, the lapping edges are rounded off.

It will be readily understood that any extent of surface may be thus produced by placing the required number of horizontal and vertical bars or strips side by side each other, and interlaced, as above set forth; and in order to secure the same, when so platted or interlaced, they being previously placed in the position suitable and made in the form required for the structure to be produced, are then heated by any ordinary arrangement of furnace, suspended so as to be capable of being brought in contact with the surface of the metal, which, when heated to the required degree, is then welded. The patentee prefers, however, coating the strips or bars of metal with tin, lead, or any other suitable metal, so that when they are platted together, they are heated as above mentioned and soldered. The metal plates thus formed or produced may be applied to the construction of metal ships, &c., the strips or bars being made of suitable dimensions for such structures.

Having thus described and ascertained the nature of the invention, and the manner in which the same is to be performed, the patentee states that he does not confine himself to the precise arrangements described, as the same may be varied without departing from the principle of the invention.

Claims.—1. Producing extended surfaces of metal by uniting a number of bars or strips in such manner that they are interlaced or platted together.

2. Welding and soldering the metal bars or strips together, so as to form extended surfaces.

PREPARATION OF COAL FOR BURNING, AND CONSTRUCTION OF FURNACES.

A. M. M. de Bergevin, Paris, *Patentee*, January 29, 1856.

This invention consists in preparing coal for burning, and in the furnaces employed for consuming such coal. For these purposes the coal is first coated with a combination of bicarbonate of soda and nitrate of potash, or other salts, of an alkali or alkaline earth in solution, in which lime is mixed, so as to produce a cream-like mixture, into which the coal is placed, so as to obtain a coating all over each piece. The coal is then dried by natural or artificial means. This prepared fuel is suitable for burning in locomotive, marine, and other steam boiler furnaces, and also in other furnaces and fire-places, and also for refining iron. In constructing furnaces for consuming such coal, it is found desirable to arrange them in such manner that numerous streams of air may pass in at the sides and front of each furnace or fire-place, and it is also desirable to have two sets of fire bars one above the other, the upper fire bars presenting a larger area than the lower fire bars. Between the two sets of fire bars numerous streams of air are introduced. By these means coal may be burned without giving off smoke.

CEMENT OR PLASTER.

A. Francis, Wandsworth-road, *Patentee*, March 1, 1856.

This invention relates to a combination of borax with gypsum (sulphate of lime), and other calcareous substances for the production of a composition to be used as a cement or plaster. The patentee states that he is aware it has heretofore been proposed to combine borax with gypsum to produce cement or plaster, but in such case a solution of the borax was first obtained, with which was combined a solution of cream of tartar, and the gypsum (deprived by heat of the water of crystallisation) was then placed in the compound solution, in order to its combining therewith by absorption, for which purpose it was necessary that the gypsum be allowed to remain a considerable time in such solution. The gypsum thus treated was then subjected to a red heat, and afterwards reduced to powder by a suitable means. But such process has been found laborious and expensive, and it is now proposed to combine the borax with the gypsum in a dry state, for which purpose the gypsum or other calcareous substance is first subjected to heat to calcine it, and is then mixed with the dry borax, ground or otherwise reduced to a granulated or powdered state without the aid of heat or of the cream of tartar or other such acid, whereby a considerable economy in manufacture is effected, a superior composition is produced applicable to various purposes, for which plaster of paris has heretofore been employed, but much more durable and better capable of receiving a hard and enamelled surface.

It is important to reduce the dry borax to a very fine powder, and then to sift it by means of a very fine sieve before mixing it, and in this finely powdered state it is mixed with calcined gypsum or other calcareous substance, reduced by grinding or otherwise to a very fine powder; the mixing is effected by means of a machine, such as ordinarily used in mixing other compositions for cement, or by other suitable means, by which to insure the matters being well mixed. The proportions of the compositions found to answer well are 40 to 50 lb. of dry borax to 20 cwt. of calcined gypsum, but these proportions may be varied.

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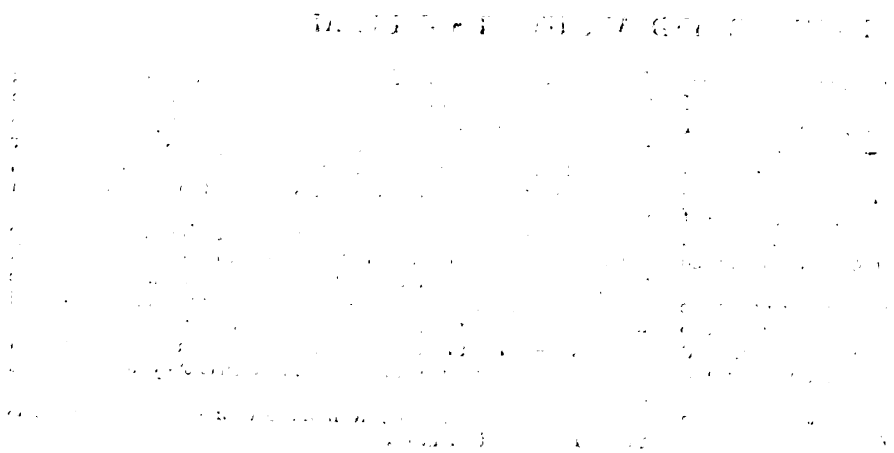

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Ryder's Steam Engine Slide Valves.

Kershaw's Imp.d Apparatus to prevent the Explosion of Steam.

Fig. 1.

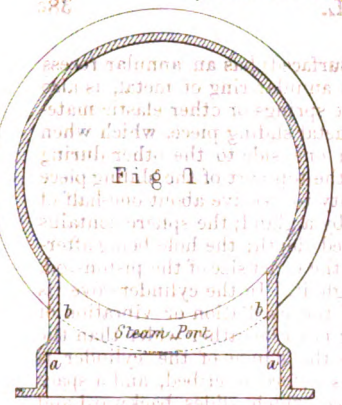


Fig. 2.

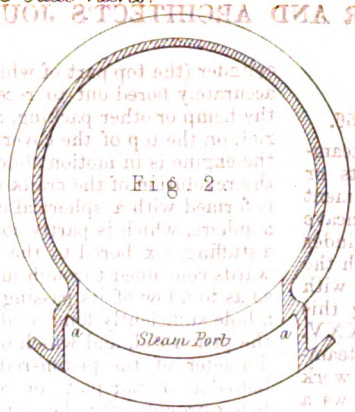


Fig. 8.

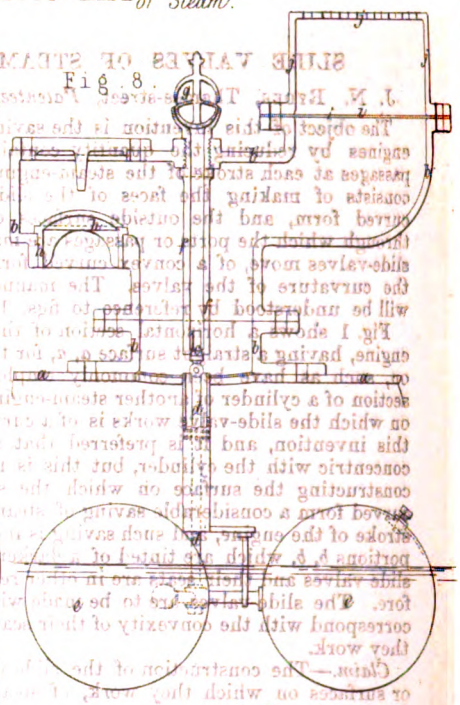
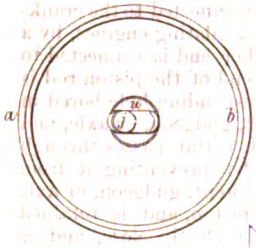


Fig. 7.



Young's Steam Engines.

Fig. 5.

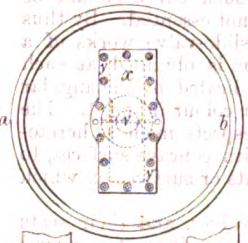


Fig. 3.

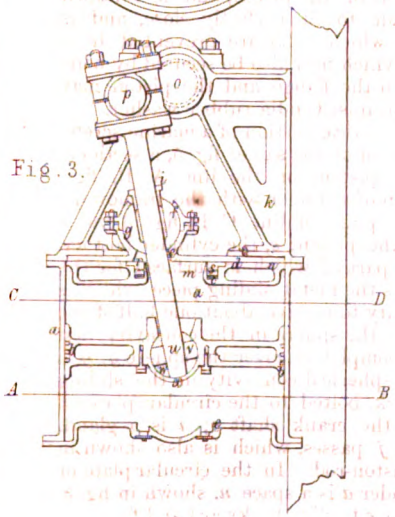


Fig. 6.

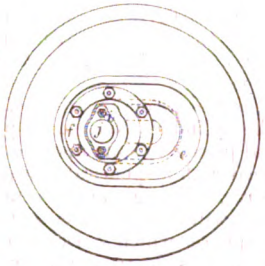


Fig. 4.

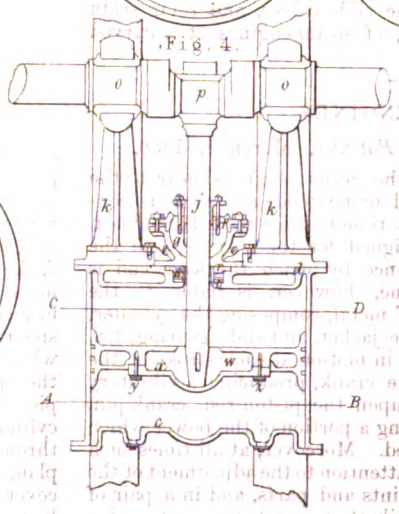
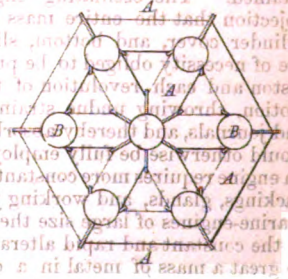


Fig. 10.



Douglass' Lighthouses Beacons Pier &c.

Fig. 11.

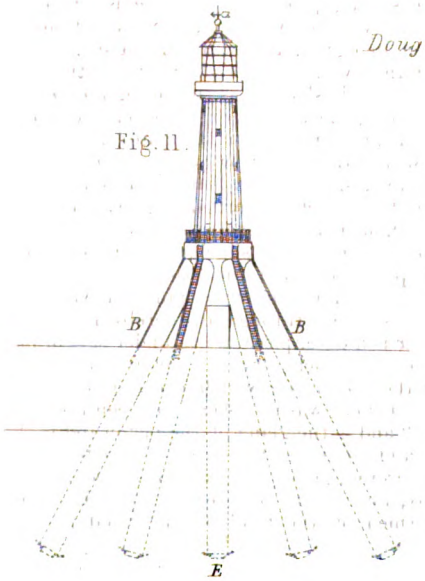


Fig. 12.

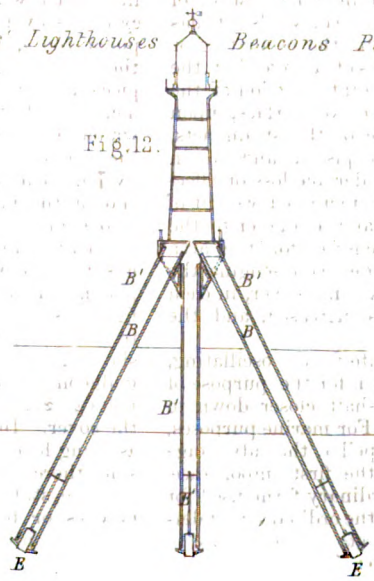
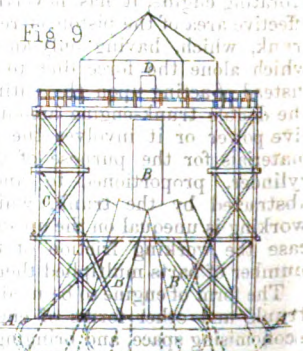


Fig. 9.



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SLIDE VALVES OF STEAM ENGINES.

J. N. Ryder, Thames-street, *Patentee*, March 12, 1856.

The object of this invention is the saving of steam in steam-engines by reducing the quantity contained in the ports or passages at each stroke of the steam-engine. The improvement consists of making the faces of the slide-valves of a concave curved form, and the outside surfaces of the steam-cylinder through which the ports or passages are made, and on which the slide-valves move, of a convex curved form, to correspond with the curvature of the valves. The manner of performing this will be understood by reference to figs. 1 and 2, Plate XXXV.

Fig. 1 shows a horizontal section of the cylinder of a steam-engine, having a straight surface *a*, *a*, for the slide-valve to work on, such as have been commonly employed. Fig. 2 shows a section of a cylinder of another steam-engine, where the face *a*, *a*, on which the slide-valve works is of a curved form, according to this invention, and it is preferred that such curve should be concentric with the cylinder, but this is not essential. By thus constructing the surface on which the slide-valve works of a curved form a considerable saving of steam is obtained at each stroke of the engine, and such saving is indicated by the angular portions *b*, *b*, which are tinted of a darker colour in fig. 1. The slide valves and their seats are in other respects made as heretofore. The slide-valves are to be made with concave surfaces, to correspond with the convexity of their seats or surfaces on which they work.

Claim.—The construction of the slide-valves, and their seats or surfaces on which they work, of steam-engines of a curved form, as described.

STEAM ENGINES.

H. B. Young, Barnstaple, *Patentee*, March 8, 1856.

The importance of bringing the crank shaft as near to the cylinder cover as possible is well understood, and various contrivances have been effected from time to time with that object. The oscillating cylinder was designed for the purpose, and the trunk-engine is another contrivance by which the same end is attained. The oscillating engine, however, is liable to the objection that the entire mass of metal, composing the cylinder, cylinder cover, and bottom, slide jacket, and slide gearing, &c., are of necessity obliged to be put in motion at each stroke of the piston and each revolution of the crank, producing a vibratory motion, throwing undue strain upon the piston-rod, crank-pin, and journals, and thereby absorbing a portion of the power which would otherwise be fully employed. Moreover, at all times such an engine requires more constant attention to the adjustment of the packings, glands, and working joints and parts, and in a pair of marine-engines of large size the vibration and torsive action due to the constant and rapid alteration of the direction of motion of so great a mass of metal in a contrary direction on each side of the keel does effect and tends considerably to impair the speed of the vessel. In the trunk-engine, in which form, whilst it has not the peculiar disadvantages belonging to the oscillating or vibrating engine, it has nevertheless the disadvantage that the effective area of the piston is reduced by the introduction of the trunk, which, having only an annular ring-like surface, upon which alone the force due to the pressure of the steam acts, instead of acting upon the entire area of the piston; and this in the double trunk-engine amounts to a considerable loss of effective power or it involves the necessity for increased weight of materials for the purpose of giving a greater diameter to the cylinder, proportioned to and to compensate for the area abstracted by the trunk, whilst in a single trunk-engine the working is unequal on the up and down stroke; moreover, in each case the working friction of the piston is increased, and the number of parts multiplied thereby.

The form of engine to be used as a substitute for the oscillating, trunk, and other forms of engines designed for the purpose of economising space, and bringing the crank-shaft closer down to or nearer to the cylinder is thus described. For marine purposes, and particularly for working the screw propeller, the advantage sought to be attained is known to be of the first importance. The patentee employs a cylinder of the ordinary form used for fixed cylinder-engines, but instead of using the ordinary cylinder-cover, piston, and piston-rod belonging thereto, he substitutes a cylinder-cover of the following description: The cover of the cylinder (the top part of which is surfaced) has an annular recess accurately bored out to receive an annular ring of metal, as also the hemp or other packing, and the springs or other elastic material; on the top of the cover is a metal sliding piece, which when the engine is in motion slides from one side to the other during the revolution of the crank shaft; the top part of the sliding piece is formed with a spherical concavity to receive about one-half of a sphere, which is partly covered by a gland; the sphere contains a stuffing-box bored to the required depth; the hole being afterwards continued through must be the exact size of the piston-rod, so as to allow of its passing through it. In the cylinder-cover is a hole sufficiently long to allow of the oscillation or vibration of the piston-rod, and which opening must be rather wider than the diameter of the piston-rod. To the flange of the cylinder is bolted a circular plate or cover, as before described, and a space being provided for the sliding piece, which slides backward and forward during the revolution of the crank shaft between a metal ring (the inside of which is perfectly planed and made accurate) and the cylinder-cover. The piston-rod is connected to the crank-pin in a manner similar to that used in oscillating engines, by a T-headed block with brasses, and the other end is connected to the piston in the following manner: The end of the piston-rod is turned slightly conical, to fit into a corresponding hole bored in the boss or spherical part of the ball joint, gudgeon, or axle, and is firmly retained there by a cottar, which cottar passes through the boss and is retained by pins, thereby preventing it from sliding back. One-half of the bottom ball-joint, gudgeon, or axle attachment is fitted into a recess in the piston, and is retained there by a cover, which is made to fit perfectly close, and is securely held down by bolts, which bolts are prevented from unscrewing by a guard frame, which may also be secured by bolts or otherwise; the joint between the flange and the piston may be kept tight by means of a vulcanised india-rubber washer.

Fig. 3, Plate XXXV., is a vertical section of a marine screw-engine, and fig. 4 is a cross section of the same; fig. 5, a sectional plan, looking underneath the piston, on the line A B, figs. 3 and 4. Fig. 6 is a plan of top of cylinder with the framework removed; fig. 7 is a sectional plan on line C D, figs. 3 and 4. *a*, *a*, is the steam-cylinder; *b*, the piston; *c*, the cylinder bottom; *d*, the cylinder-cover, the top part of which is surfaced for the metal piece *e* to slide upon; *e* is the metal sliding piece, which is formed with a spherical concavity to receive about one-half of the sphere *g*; *f* is a gland to secure the sphere in the concavity, and which will be seen does not completely cover the sphere *g*; *g* is the sphere, which works in a spherical concavity in the sliding piece *e*; *k* is the iron framework, bolted to the circular plate on cylinder-cover for supporting the crank shaft *o*; *i* is a gland, through which the piston-rod *j* passes, which is also shown in plan, fig. 6; *j*, the vibrating piston-rod. In the circular plate or cover bolted to the top of cylinder *a* is a space *n*, shown in fig. 3, being provided to allow the plate *e* to slide backward and forward; *l* is a metal ring, better shown in plan, fig. 6, one part of which is secured by bolts to the circular plate, and the other part is in contact with the sliding piece *e* in fig. 1; *m* is a hole in the cylinder-cover sufficiently long to allow of the oscillation of the piston-rod *j*, as seen in figs. 3, 4, and 6; *n* is a space between the metal ring and the cylinder-cover *d*, in which the sliding piece moves; *o* is the crank shaft; *p* is the crank pin; *r* is the hemp or other packing; *s*, the springs or other elastic material, which are let into an annular recess in the cylinder cover *d*; *p* is the crank pin, to which the vibrating piston-rod *j* is attached, by T-headed brass bearings, or a block fitted with brasses; *u*, the end of the piston-rod *j*, which is turned slightly conical to fit into a corresponding hole bored in the boss or spherical part of the ball joint, gudgeon, or axle *w*, shown in plan, figs 5 and 7: *v* is a cottar, which passes through the boss and conical end of piston-rod, and is retained by the cross pins, shown in plan, fig. 5, as passing transversely through it, thereby preventing it from slipping back; *x* is a cover piece on the under side of piston, shown in plan, fig. 5, and which serves to retain the ball joint, gudgeon, or axle *w*, the closeness of which can be adjusted by the bolts *y*· *z* is an india-rubber washer, placed between the nut and the cover. In figs. 3 and 4 the gland of the piston-rod is shown as being held down and tightened by means of two bolts at the sides thereof, but a screwed gland may be substituted, and fitted into the stuffing box, and which may be set down by means of notches or teeth formed on the head of the gland piece, into which a suitable spanner will take. It is also proposed when necessary to form the annular rings, slides, and fittings on the

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cylinder-cover with a double step or break in section, so as more effectually to check and prevent the escape of steam.

It will be seen that engines made according to this invention have none of the grave objections and disadvantages of the oscillating or trunk forms of engines pertaining thereto, whilst the parts added and substituted are surfaces of the simplest form, capable of being readily and correctly turned, bored, and planed by machinery, and which may be accurately adjusted with facility. The crank may thus work close to the cylinder-cover with a piston-rod of the shortest length, and without the intervention of a connecting rod, crosshead, guides, or other similar contrivances between them. The slide valve may be worked direct from an eccentric on the crank shaft by placing the valve chest and connections on the proper side of the cylinder, or it may be worked in any other suitable manner.

Claim.—The application of a fixed cylinder, not having a trunk working therein, of an oscillating or vibrating piston-rod, one end of which is connected to the piston by the means described, and the other end is connected directly to the crank pin, without the intervention of a connecting rod, slings, or other similar contrivances, and so by the means described, or the mechanical equivalents therefor, enabling the free vibration of the piston-rod through the cylinder-cover without the escape of steam therefrom.

STEAM BOILERS.

J. Kershaw, Stockport, *Patentee*, January 25, 1856.

This invention consists in a combination of a float with a valve, and whistle or signal, whereby notice is given when the level of the water in a steam-boiler is too low; also in the application of a collapse valve to boilers furnished with exploding plates. Fig. 8, Plate XXXV., is an elevation of the apparatus; *a* is part of the boiler, to which is attached by rivets or otherwise the box or casing *b*; the valve *c* is joined to the upper end of the rod *d*, and to this rod is attached the float *e*, which may be made of one, two, or more hollow metal balls, according to circumstances; the seating of the valve *c* is made at the lower end of the tube *f*, screwed above in the box *b*, and in communication with the whistle *g*. A compensating valve may be used, instead of the one shown. *h* is a collapse valve of the usual construction; and *i* is a plate of metal, the strength of which is calculated so that it will explode when the pressure of the steam in the boiler becomes greater than the boiler may with safety bear; this plate, which is in communication with the atmosphere through the openings in the lid *j*, forms no part of the invention. The mode of operation is as follows: As long as the level of the water in the boiler is not too low, the valve *c* is held closed by the float *e*, but as soon as the level of the water is too low, the weight of the float *e* overcomes the pressure of the steam acting against the under side of the valve *c*, consequently the valve *c* opens, whereby a portion of steam is allowed to escape, and rushing up the tube *f*, causes the whistle *g*, to give notice. The escaping steam instead of acting on the whistle *g*, may be otherwise disposed of to give the required notice. The object of the collapse valve *h*, as is well understood, is to admit air to the boiler in case of a partial vacuum being formed therein; when boilers are provided with exploding plates, such as the one marked *i*, it is very important to prevent the action of the air on the upper surface of the plate. When the pressure within the boiler exceeds the pressure of the atmosphere, the pressure on the plate *i* has a tendency to force it outwards, but as soon as the pressure in the boiler becomes less than that of the atmosphere, the pressure on the upper surface of the plate would, if the collapse valve were not applied, depress the plate, and these constant actions on opposite sides of the plate would be very injurious to it.

Claim.—The improved apparatus described, for preventing the explosion of steam-boilers, and the application of a collapse valve in combination with an exploding plate.

CONSTRUCTION OF LIGHTHOUSES, BEACONS, PIERS, &c.

N. Douglass, St. George's-in-the-Fields, *Patentee*, Dec. 27, 1855.

This invention consists chiefly of a mode of employing wrought or cast-iron or other metal cylindrical piles, peculiarly constructed for their external preservation, for the foundations of marine and other like structures, which cylinders being hollow, are floated by means of a novel arrangement of pontoons, carrying several cylindrical piles in position; and applies also to giving increased strength to iron lighthouses and like erections by adopting the form of fluted corrugations.

Fig. 9, Plate XXXV., is an elevation of lighthouse cylinders and staging afloat; fig. 10 is a plan of pontoon; fig. 11 is an elevation of a lighthouse erected on shoal of loose material; and fig. 12 is a section of fig. 11. A, A, is the improved pontoon, formed of horizontal tubes; B, B, are cylindrical piles, with B^1, their external protective metal casing and bituminous lining; C, strong wood framing, surmounted by D, barracks for workmen; and E is the cylindrical-hinged flanched expanding foot, with E^1, a guide rod, for forcing out and securing the same to give stability to the foundations of the piles, particularly in shoal of loose material.

It will thus be seen that the pontoon is hexagonal, or of any desired figure, by laying tubes horizontally, and bolting them together in such a manner as to carry any required length of cylindrical piles, either vertically or at any desired angle, in position ready to be erected, each pile closed at bottom to exclude water, and increase the buoyancy of the pontoon. On the pontoons is erected a substantial wood or other framing, carrying above a suitable barracks for the accommodation of tools, stores, and workpeople, and also a travelling crane and other apparatus. Over the cylindrical piles is passed an external cylinder of sheet metal, and run in between them melted bitumen to act as a preservative coating. The interior of the piles at their base is closed or nearly closed with a flanched foot-piece, which can be spread out externally after the piles are in their places, to add to their stability. The interior of the piles can afterwards be filled with concrete or any suitable material, and in like manner also in some cases the spaces between the piles. When building on submerged rock, a man-hole cover is applied to the cylinders, and air forced into them, and they can then be used similarly to the diving-bell. The fluted form of the tower is novel in the construction of lighthouses, and adds materially to the strength of such or like erections.

Claims.—1. The peculiar construction of pontoons, with staging and barracks, for transporting and erecting hollow metal piles.

2. The novel construction and arrangement of hollow metal piles.

3. The application of fluted or corrugated iron in the construction of lighthouse towers and similar erections, as described.

Ventilation and Furnace-draught of Steam Vessels.—Mr. C. Wye Williams, proposes, in the specification of a patent just completed, to employ the ordinary rotatory fans, or other description of blowing or exhausting apparatus, worked by a small independent engine, or by being connected with the marine engine, for the purpose of obtaining an improved draught of air. The details of the invention are as follows:—He proposes to ventilate the cabins, hold, and other places, by the exhaustion or propulsion of air in pipes or other air passages circulating through different parts of vessels, providing such suitable outlets or inlets, perforations, valves, or similar contrivances, as may be required. He also employs the same mechanical arrangements to exhaust the products of combustion from the engine-boiler furnaces by the funnels, and thereby promote the combustion of the fuel; or he sometimes causes the air to be forced into the engine and stoke rooms, by which means the furnaces will be better supplied with air.

Excavating Machines.—Mr. W. Curtis, of Islington, has invented an improvement in combining machinery for excavating land for constructing tunnels. For this purpose, a rectangular or suitable form of frame, of a size depending on the intended tunnel, is constructed, and is arranged, when placed in an upright position, to be moved forward by hydraulic pumps or mechanical means pressing against the work which has been completed. There are three uprights, the two outer ones have reverse screw threads formed thereon in such manner that a screw nut on each of them, when caused to rotate, shall ascend its upright, and then when it arrives at the end again descend. These nuts turn between two plates, which carry an endless chain, and chain wheels by which the chain is carried. The central upright is a shaft which gives motion to the chain wheels and chain. In order to cut or remove the land in front, the chain carries ploughs or cutters, which cut away the land in front as the chain is caused to move. The central upright or shaft is put in motion by a steam-engine, which moves on suitable rails up to the work.

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PATENT APPARATUS FOR THE DISTILLATION OF FRESH FROM SALT WATER FOR SHIPS' USE.

C. W. Copeland, C.E., New York, *Patentee.*

The accompanying engravings represent an apparatus for the distillation of fresh from salt water, and designed to prevent the inconvenience and sometimes serious results arising from the water shipped in casks before the commencement of the voyage, turning putrid and unfit for use; or from its being insufficient in quantity owing to delay on the voyage.

Fig. 1 is a sectional elevation, fig. 2 an end view with boiler in section, and fig. 3 a plan as arranged by Mr. How, of Mark-lane (representative of the patentee, in England), and lately inspected by the Elder Brethren of the Trinity House.

The figures will be understood by the following references. A, A, casing for furnace and boiler; B, the boiler; C, steam chest; D, D, the pipe taking the steam into the condenser E, of which F, F, are the tubes. G, is a perforated plate between the condensed water and filtering medium H. I, is the delivery-pipe; K, K, are columns supporting the tank L; M, the pipe for supplying water to the boiler; N, pipe for supplying water to the condenser; O, the overflow pipe.

The mode of operation is as follows. Steam being generated, passes from the steam-chest C, through the pipe D, into the tubes F, F, of the condenser E. These tubes, being constantly surrounded with cold water from the tank L, L, through the pipe N, rapidly condense the steam. The water thus obtained then passes through the filtering medium H, and is delivered ready for use by the pipe I.

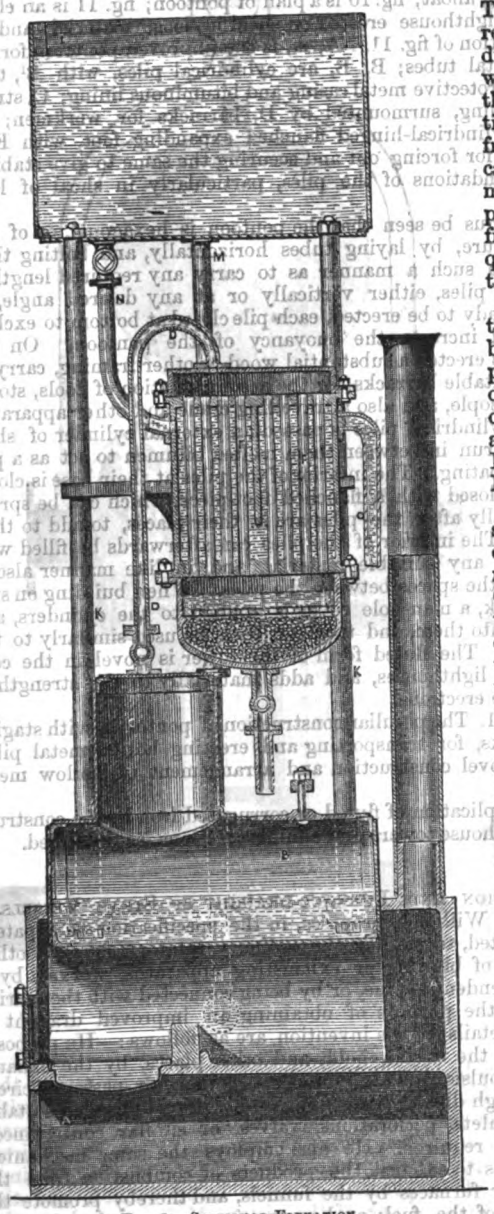

Fig. 1.—Sectional Elevation.

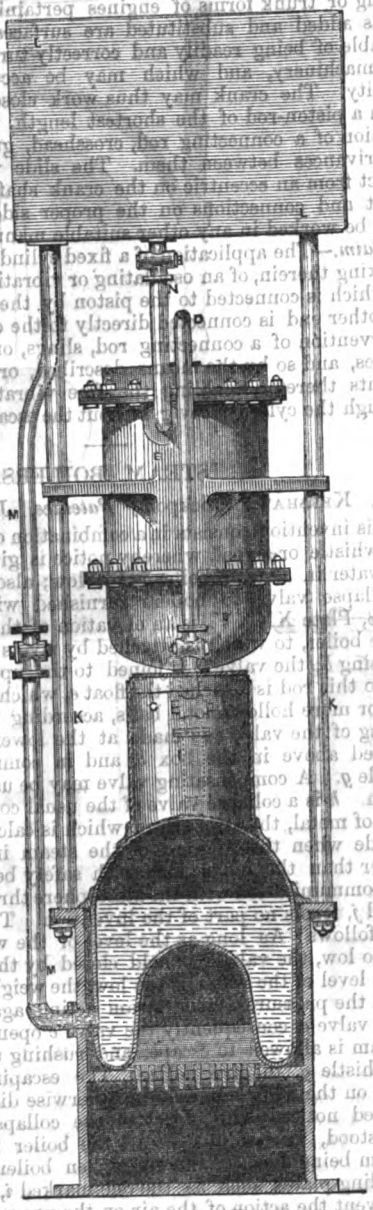

Fig. 2.—End View.

Fig. 3.—Plan.

The engravings are drawn to a scale of three-fourths of an inch to 1 foot.

The apparatus is so simple in construction that it may be taken to pieces, cleaned, and put together again in a very short space of time, and by any of the crew. It is applicable to all sea-going vessels, whether steam or sailing ships, and has been successfully applied in several cases.

Cleansing Steam-Boilers.—Mr. T. Burton, of Lincoln, has invented an "internal boiler cleaner or mud-stirrer, for the cleaning of steam-boilers from muddy deposits, and all kinds of sediments." The invention relates to the employment of a stirrer or agitator, for stirring up the sediments or deposits in steam-boilers of all kinds, whereby such sediments or deposits, when so agitated, may be run off through the mud-cock with facility. The improvement consists in fixing a stuffing-box at or near the bottom of steam-boilers, through which stuffing-box is passed a sliding-rod, on which is fixed a plate or piece of metal of larger diameter than that of the rod, so that when the latter is moved by a handle outside the boiler, it will form a stirrer or agitator.

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PATENT PUMP AND FIRE ENGINE.—A. P. How, Mark-lane, *Patentee*, August 18, 1856.

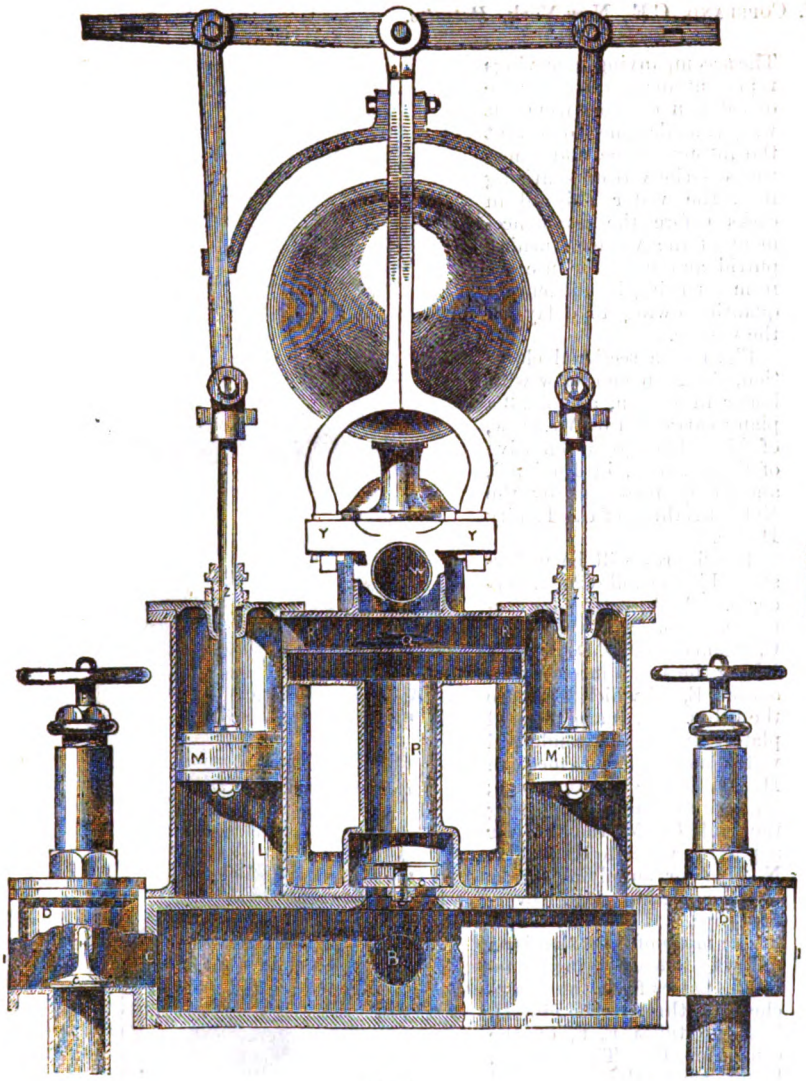

FIG. 1.

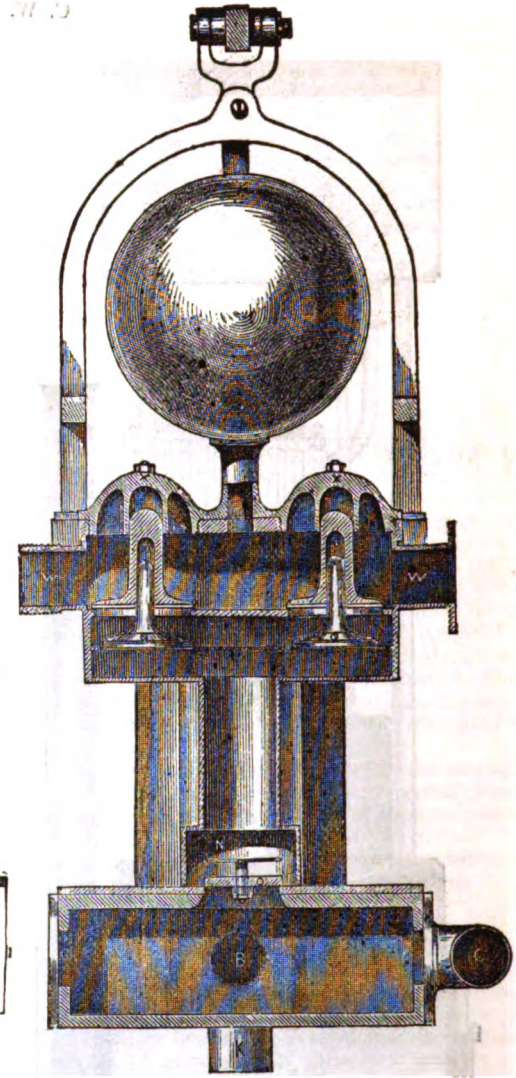

FIG. 2.

In the accompanying illustrations, fig. 1 represents a sectional elevation, and fig. 2 a transverse section of pumps. A, is a cast-iron or brass suction chamber, serving also as foundation for the pumps. This chamber has four apertures B, B, C, C; the two latter join valve-cocks D, D, which are so constructed as to act as stop valves. The wheels E, E, are used for lowering the spindles F, F, on to the valves C, C, the spindles having recesses H, cast in them, which allow the stem of the valves to rise when the wheels E, E, are used for screwing the spindles up, or effectually closing the valves when the spindles are screwed down. The cocks have two branches I and K, the one (I) to be used as suction for fire-engine, the other (K) for suction from the sea, or any other part it may be necessary to draw water from. L L, are the pump chambers fitted with pistons M M. N is the under suction-chamber, fitted with an india-rubber valve O, forming the communication between the suction-chamber A, and the pumps L L. P shows the passage for the water from the suction-chamber A, to the upper suction-valves Q, where it flows through the passages R R, to the top of the pistons M M. S S, are also water passages from the suction-chamber to the underside of the pump pistons M M. T T, are the delivering valves, having recesses U U, allowing the stems of the suction-valves Q Q, to rise in them, thus acting as guides. V is the delivery-valve-box, having branches W, on it, to which may be attached the delivery-pipes or fire-hose, as may be required. The cap X, of the valve-box V, is also fitted with a recess in which the stem of the delivering-valve T, rises, thus acting as a guide for both the delivering and suction-valves. Y Y, are lugs cast on the delivery valve-box for taking the standard which carries the beam for working the pumps; this beam being connected with side-rods to the piston-rods. Z Z, handles with sockets that may be shipped or unshipped from the beam as the work requires, more or less power being provided. Either of the openings B B, or C C, of the suction-chamber being opened, and the pump set to work, if one of the pistons M, is going down, the other going up, the water flows through the india-rubber valve O, into the passage P, raises the upper suction-valve Q, thence passes through the passage R, to the top of the pump-piston M; at the same time the pump-chamber under the piston being full of water, delivery takes place through the passage R, to the top of the upper suction-valve Q, raises the delivering-valve T, and is forced out of one of the delivery branches W. At the same time the other pump-piston going up, the pump-chamber having filled on the top of the piston by the up-stroke of the other one, the delivery takes place through the passage R, above the upper suction-valve Q, the suction taking place under the piston through the valve O, thence proceeding through the passage P, lifting the upper suction-valve Q, and passage S. The operation is thus continuous, and the delivery takes place twice at each up, and the same at each down, stroke.

Claims.—1. The mechanical arrangement of the pumps, valves, and passages, each pump being double acting, by the disposition of the passages as described above; thus having two double-acting pumps occupying but little more room than a single one of the ordinary construction.

2. The simplicity of construction and detail, the suction-

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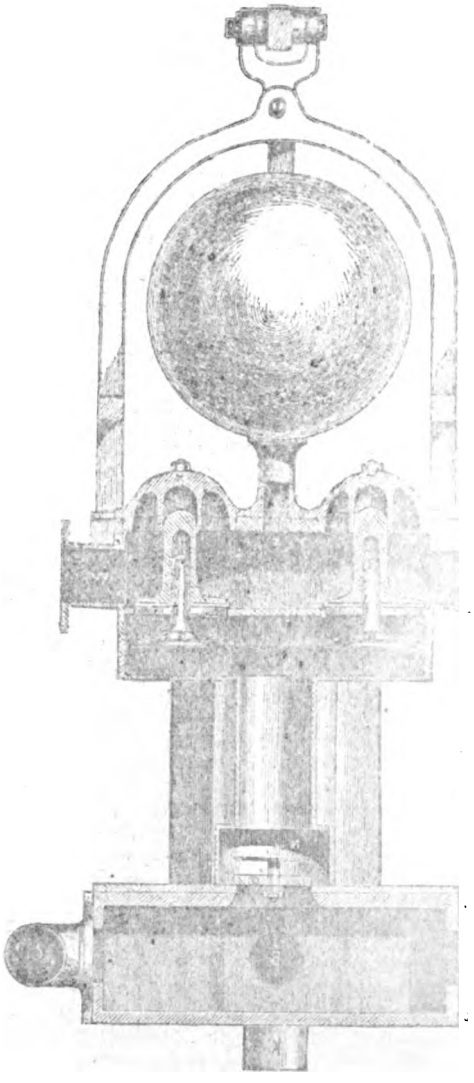

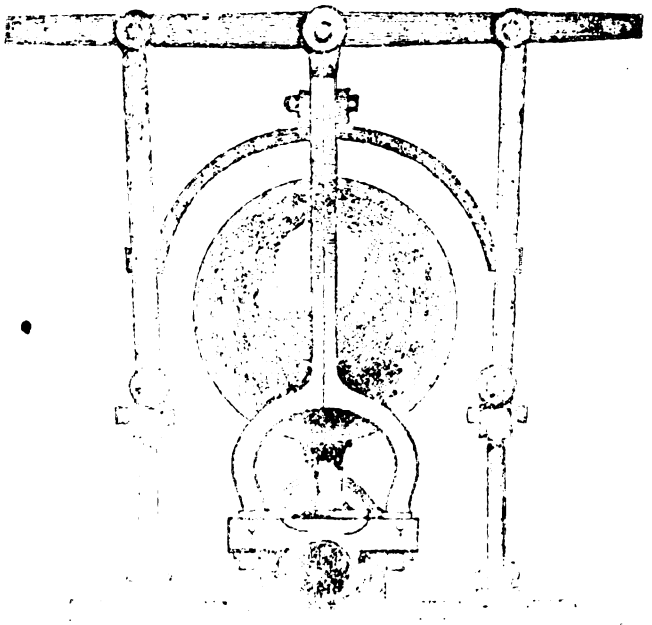

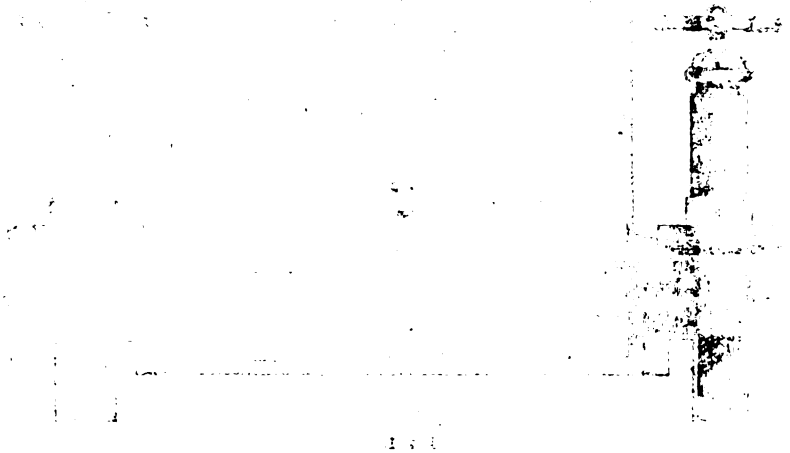

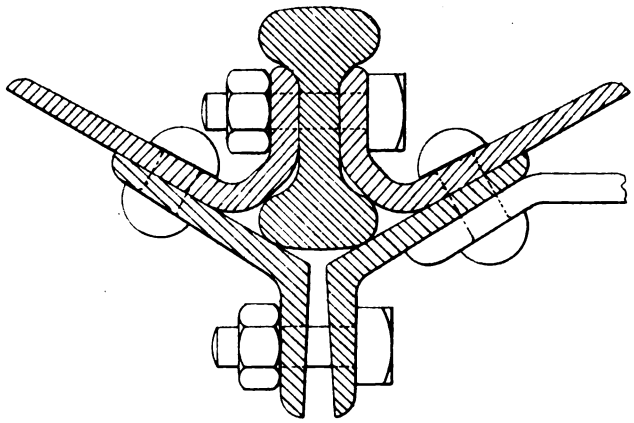

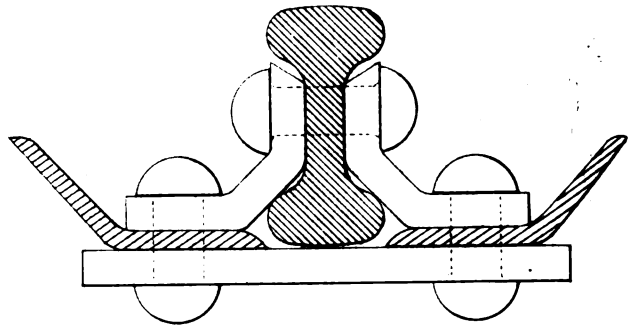

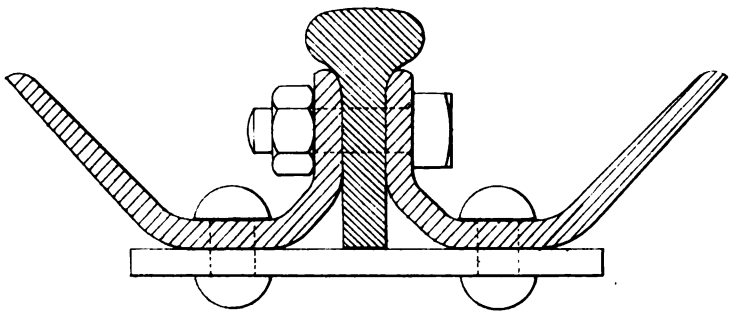

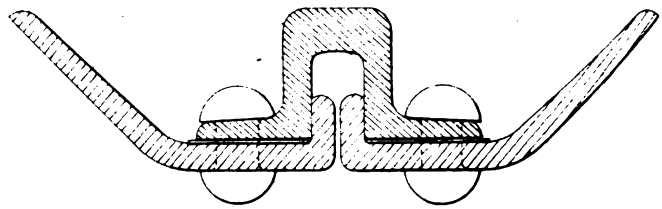

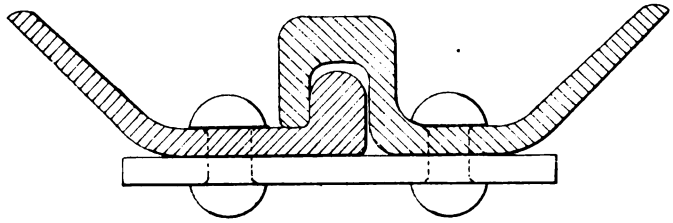

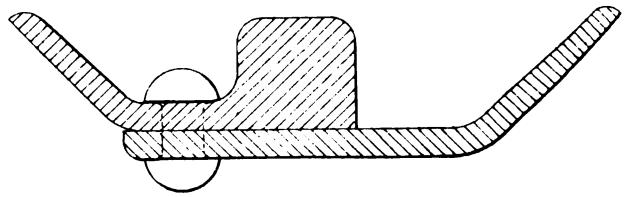

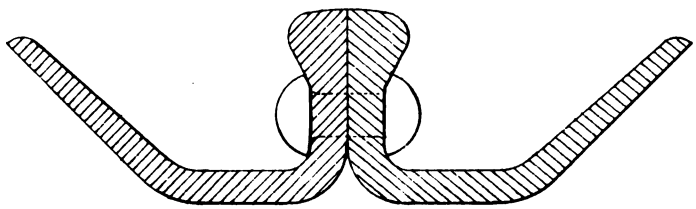

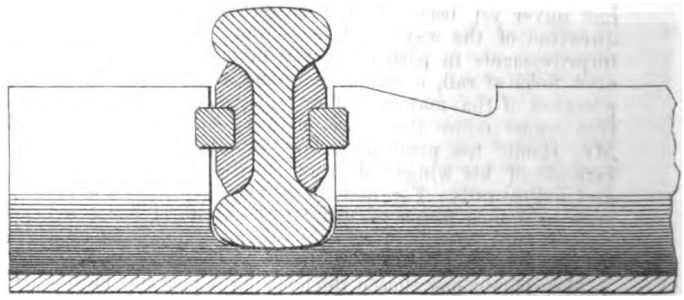

Rail with Portion of Cross Sleeper

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chamber forming the foundation being cast in one piece, either of brass or cast-iron; the pump-chambers, suction and delivery passages being also one casting. The facility with which the valves may be examined, only requiring the cap to be unscrewed from the valve-box, the valves being under immediate inspection, as they are placed at the top.

3. The durability and simplicity of this pump, five valves only being required, thereby causing a great saving in weight of material and cost of workmanship. It is particularly valuable for vessels on account of the great power it posseses for throwing a large volume of water with unusual rapidity, in case of fire, and on account also of the small space it occupies.

4. The advantages are similar when applied to land fire-engines, for which it is equally well-adapted.

PERMANENT WAY FOR RAILWAYS.

(With Engravings, Plate XXXVI.)

Among the many recent inventions for improving the construction of permanent way, we remark those of Mr. C. W. Ramié; and as it is a desideratum to obtain a way which shall as far as possible be permanent in structure as well as in name, we take pleasure in noticing every step in the right direction; for notwithstanding the several modes of preserving timber, the desired permanency is as yet only met with in the permanent and prominent position of those bugbear items which are presented to shareholders in annual reports, under the head of "Maintenance of Way." The importance of the subject has caused it to be a favourite one with inventors, in whose hands it has assumed, within the last few years, an almost endless variety of forms, some of which are merely trifling deviations from the present systems, others too costly, and some impracticable. Stone sleepers have been tried and rejected; wooden sleepers are found objectionable, not only on account of their liability to rapid deterioration and decay, but also by reason of the difficulty which exists in maintaining a lastingly firm and secure connection between them and the rails which they are intended to support; and in cast-iron sleepers we have the objection of great weight for a required strength. Hence, it appears, that malleable iron is the material best suited to meet the combined requirements of permanency and moderate cost. Mr. Ramié appears to have taken this view, and to have carried it out in a manner at once simple and practical. In the accompanying Plate are several sectional representations of some of Mr. Ramié's various modes of construction, whereby it will be seen that a main feature of the invention is that of employing a wing or plate of malleable iron, inclining upwards on each side of the rail. This mode of supporting the rail possesses, we think, many advantages; among which may be instanced decreased cost of laying, and, in case of settlement along the line, of facility of repacking without the removal of either part or causing a stoppage. We also think it possible that in some cases the amount of ballast employed might be greatly diminished without in any way detracting from the qualities necessary to a solid, easily repairable, and lasting system. These items of saving both in first cost and maintenance will doubtless be considerable, and have the further advantage of being effected by a system which seems in every other respect greatly superior to the temporary structure now in use; for where malleable iron sleepers are employed, the rail-head alone may, for practical purposes, be considered the only perishable portion of the way, inasmuch as that the mere oxidation of the sleepers would be so slow as to permit their use over a period of time such as a shareholder has never yet been allowed to reckon upon as the possible duration of the way so dear to him. Most of the previous improvements in permanent way involve the introduction of a new form of rail, a condition ill-suited to the present financial position of the majority of railway companies. In the invention under notice this objection has been avoided, inasmuch as Mr. Ramié has provided several simple and economical adaptations of his winged sleepers to the ordinary double-headed and bridge rails. For new lines there are shown various new and ingenious forms of rail which admit of being reduced in weight and consequent cost, or otherwise modified to meet the requirements of any given amount of traffic.

Mr. Ramié has chosen the longitudinal as the most desirable position for a rail-support, but has nevertheless provided various modes of attaching rails to cross sleepers constructed on a principle similar to that of his longitudinal system; one of these, represented in the last figure, is particularly simple, the parts being merely held and tightened together by a key, the withdrawal of which permits the removal of the rail. We also observe that the key beds employed in this instance prevent any lateral or horizontal deviation of the ends of the adjacent rails, and thus obviate the necessity for the fish-joint now in use.

We should judge that in most cases the space between the sides of the rail and the inclined wing may be filled up; but this is apparently an immaterial point; in fact, the existence of the channel or trough thus formed along the sides of a rail, might be the means of preventing a train which had slipped from the rails from leaving the line.

On the whole, we cannot but consider that the durability of the material employed, the simplicity of the parts, and facility of laying and repairing, without taking into consideration the probable saving in first outlay—give to this system a foremost place among the many which have been proposed for the improvement of permanent way.

STRENGTH OF ARTILLERY.

Sir—In the last number of your *Journal*, you comment on some equations, communicated by me to Mr. Mallet, relative to the effect of internal pressure on a cylinder, in which you state that "I did not investigate the normal compression of the cylinder." Now, if you will take the trouble of reading either of my letters to Mr. Mallet, which you thus criticise, you will find that equation (2) in the first letter, and equation (9) in the second, are deduced from this very normal compression. In fact, the differences between your investigation and mine are merely these: first, you ignore the fact that the coefficients of extension and compression are not always equal; and, second, you connect the forces by an equation ($n + t = C$) derived from the assumptions that both l and λ are constant, while I connect them by the more obvious relation that the total compression is equal to the difference between the extensions of the inner and outer surfaces. But to return to the review: You profess to supply the chief defect in theory, of which I had complained, by the statement, that "When the cubical extension is introduced, experiment leads to the conclusion that the consequent additional tension is approximately in a constant ratio (E) to the cubical extension." This may be very true, but it would have been more satisfactory if you had given some reference to the experiment on which you rely, or at least if you had stated the values of E for some of the most ordinary materials; however, since by your subsequent hypotheses you eliminate E, I suppose we may conclude that the result would continue to hold if $E = 0$, and therefore that it should agree with my result; whence it appears, that the difference must arise from an inaccuracy in your assumptions that l and λ do not vary *from the inner to the outer surface*, which indeed appear sufficiently improbable in themselves, notwithstanding your subsequent argument to prove that l does not vary *in the direction of the length*, which has nothing to do with the question.

Your next statement, however is rather more startling—that the tensions of the successive rings "cannot be determined arbitrarily by any process of 'shrinking on' at different temperatures, for immediately that any one of the rings is so fastened on, it produces a normal compression and alters the tensions of all the other rings."!! To be sure it does; and that is the very way in which I proposed to vary the tensions at pleasure. But you go on to say, that "*in no case do the relative degrees of tension of the built-up gun depend on the tensions with which the ring were successively fastened on*," and that, although you admit that all the tensions are altered by the compression of each successive ring!!—the sole proof of this paradox being, that your "equation (7) is equally true whether any of the rings were stretched or compressed before the pressure p was applied." Now this equation (7) is derived from one already mentioned ($n + t = C$), the truth of which can be easily tested. It is clear that if a cylinder was empty and subject to no external pressure, we would have $n = 0$ at each surface, and therefore (if your equation be true) $t = C$ both at the inner and outer surfaces. Now, let this cylinder be a common tub, whose outer surface consists of hoops, and the inner surface of staves, and I think you will find that t is negative at one surface and positive at the other, instead of being the same at each surface. You seem determined, however,

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to force your strange conclusion on your readers by every possible variety of words and type; in capitals, you declare that the tension depends "SOLELY on the magnitude of the rings;" in italics, that it does not depend "*on the tensions with which the rings were successively fastened on*;" and again, in ordinary type, that "whatever the tensions and compressions might have been originally.....the tensions of the complete gun must increase from the interior outwards in quantities proportional to the square of the distance from the axis of the cylinder, as in equation (7)." (This equation, by-the-by, leads to a directly opposite result; but that is a trifling error). You proceed: "To suppose that, by any means of preparing the gun, this difficulty" (the difficulty of varying the pressure) "could be avoided, would be to suppose that the ingenuity of man could evade the laws of mechanics." Why, Sir, if you will only put your finger between two staves of a tub while the cooper drives on the hoops, you will soon learn whether his "ingenuity" does not alter the pressure; or if you would prefer an example of the mode of varying the pressure which I suggested, namely, by "shrinking on at different temperatures" any wheelwright can supply you with one.

It seems useless to pursue the analysis of your review any farther; and indeed I must confess my inability to attach any definite meaning to the rest of your calculations. Perhaps the November number may throw some light upon them.

ANDREW S. HART.

Trinity College, Dublin, Oct. 25, 1856.

[We will reply to this letter in our next number.—ED.]

THE PRINCESS' THEATRE.—"MIDSUMMER NIGHT'S DREAM."

IT is not often that we step out of our way to treat of theatrical matters, but when certain pieces are produced on which a lavish expense has been incurred, and the manager has evidently bestowed equal attention on the minutiæ and the *tout ensemble* of the work, he is fairly entitled to some share of notice at our hands, especially since such productions being witnessed by the mass of the people must have some influence in directing the public taste. Foremost among those who have exemplified this attention must be deemed Mr. Charles Kean, whose revival of the "Winter's Tale," we took occasion to review at some length in our July number. The subject then admitted of copious architectural illustration, and advantage was taken to exhibit Sicilian features in varied lights. In the "Midsummer Night's Dream" the scene is laid in Athens, and, to follow the chronological date of the time of Theseus, in whose reign the incidents are supposed to take place, the city should wear its pristine and uncouth aspect. As this, however, would be neither attractive nor instructive, a period long subsequent has been adopted, which displays that imposing city in the zenith of her prosperity: and as this does not interfere with the consistency of the plot, the substitution is not only allowable, but to be commended. This, then, is the scene with which the play opens; the spectator being supposed to view it from a terrace adjoining the Palace of Theseus, which overlooks the whole. The Acropolis, as may be imagined, constitutes the central mass, on whose lofty site the several temples and the colossal statue of Minerva are boldly conspicuous. Immediately below the Acropolis is seen the Theatre of Bacchus, and scattered about the landscape other well-known buildings, the majority of which are shown polychromised. Although this scene apparently lacks finish, being in many respects hard in the outline, it forms a majestic grouping, which the characteristic blue atmosphere of the country sets off to advantage. As to the "Workshop of Quince, the Carpenter," the whole of the objects are depicted on the flat, and we might have been disposed to question their antique pretensions were we not informed that the furniture and tools are copied from discoveries at Herculaneum. The concluding scene, a supposed interior of the Palace of Theseus, shows a peristyle of Corinthian columns, with drapery hung round the lower part. By the ingenious machinery so often exercised during the piece, this suddenly is withdrawn, disclosing the festive mirth and merry-making of the vast assemblage behind as they maze about "through this house." The architectural details are all in polychrome, and pretty satisfactory; still it seems rather injudicious to employ as the "Order" that which is identified with the Monument of Lysicrates, and that alone. Nor are the deviations made in reproducing the entablature any improvements, the absence of a sculptured frieze being greatly felt.

The scenery of the piece generally, with the exception of what we have quoted, is in landscapes, treated with marvellous skill, especially when the aid of the electric light is brought into requisition. Scarcely anything can be imagined more gorgeous than the varied colours in the garlands of the maypole in the fourth act, at once the mechanical and pictorial climax of the piece,—or the intensity of light thrown on the stage when the fairies assemble and indulge in their graceful "shadow dance." Perhaps the only effect to be compared with it was the almost supernatural representation of Queen Katharine's dream, in some respects still more wonderful. In "Faust and Marguerite,"—the ghost scene in "Macbeth,"—and the statue scene in the "Winter's Tale," its potent aid was also visible, and with what success no spectator will easily forget. A new era in scene-painting has dawned, and we look for its still further development; but it must be in the legitimate pursuit of harmonious contrasts, not merely startling effects. The play of "Pizarro," which at present completes the evening's entertainment, may be cited in illustration of our meaning, for though its dazzling historical brilliancy at first attracts the eye, it is sometimes so taxed as to bewilder rather than delight.

WHITNASH, WARWICKSHIRE.

THE parish church of Whitnash dates back to about the year 1230, but portions of the wall near the south porch, and the remains of carved stones found in the foundation during the restoration of the chancel bear marks of a still earlier church, and point to the Norman period of architecture. The chancel having become quite dilapidated, and the walls having diverged greatly from the perpendicular, it has been recently rebuilt under the superintendence of Mr. Scott. The whole has been effected in the most laudable spirit, through the exertions of the rector, and now presents a substantial as well as consistent appearance. The exterior of the building is of a local sandstone, and the old stones were reused as far as available, and the remainder procured, by the permission of Lord Leigh, from a quarry at Cubington. The interior is lined with Bath stone. The roof is of oak, also the gift of Lord Leigh. Some monuments, brasses, and other memorials, have been put back, as nearly as possible, in their former positions. On one of these is a curious inscription, which we quote. It is to the memory of one Nicholas Greenhill, the first head-master of Rugby School, and who was for forty years rector of this parish:

"This Greenhill Periwigd with snow
Was levild in ye spring;
This hill ye nine and three did know
Was sacred to his king.
But he must down, although so much divine,
Before he rise, never to set but shine."

The windows have been entirely filled with stained glass, by Hardman, Holland, and Bell. A brass altar-rail has been furnished by Skidmore, and the pavement and reredos (which is tile of the richest description) were prepared by Minton.

ARCHITECTURAL ASSOCIATION.

THE opening meeting of the present session, held on the 3rd ult., was very numerously attended. In addition to the usual, or we might say un-usual, proportion of the younger members of the profession, there were not a few of the seniors who appeared to participate thoroughly in the objects and proceedings of the evening.

The walls of the room were hung as heretofore with a series of architectural drawings, some of a highly-interesting nature, and sundry books, carvings, and portfolios were scattered about, imparting a diversified interest. The collection of sketches by the "Class of Design," too, must not pass unnoticed. The contributors for the occasion were mostly gentlemen connected with the Society, including the President, Messrs. Goodman, Truefitt, James, Gray, Wyatt, Hill, Randall Druce, Hayward, Wigley, and Clarke.

The report having been read by Mr. Bunker, one of the Hon. Secretaries, its adoption was moved by Mr. Kerr, seconded by Mr. Gray, and carried *nem. con.* In the course of his remarks, Mr. Kerr (who formerly held the office of President) adverted to the idea which had been mooted of dissolving the Association, a proposition which he deprecated in the strongest terms, believing that though its vigour might have become impaired, there is still ample scope for its continued operations, and sufficient vitality to encourage the hope of its revival to its pristine usefulness. He next referred to the scheme of amalgamation with the Institute of British Architects, a measure which he likewise objected to, as likely to cripple its energies and to negative its

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purpose. "Until quite lately the operation of this Association was very successful; but they knew that everything had its time, and that there would occur, sooner or later, a decline in everything of this sort. However, it did not therefore follow that the principle on which the Association was founded had, in the slightest degree, been found inapplicable, or that it had been unsuccessful in its operations. He thought he might be bold enough to say that this Association had done more practical good among the young men of the Architectural profession, than any society ever established in this country."

At a subsequent period of the meeting, the sentiments expressed by Mr. Kerr in reference to the Institute were met, on behalf of the latter, by Professor Donaldson, who, in the course of a complimentary and friendly speech, thus interpreted their motives: Seeing a number of young men—zealous, ardent, and enterprising, wishful to improve themselves, and deprived of the means of doing so—they felt it would be a pity for them to be deprived of such means, and the Institute said to to them: "Come to us, and we will make you welcome; if you wish to be independent, you are welcome; but if you wish to join us, here are our books, here is our library, here is all our property, and, at the same time, you may carry on your own operations."....."His friend, Mr. Kerr, had said that the Association would have to submit to the Institute, and adopt their resolutions. The Institute wanted no submission—that would be unworthy of both; they must come on equal terms, and in an honourable way, as brother architects. That was the best way, and one that would not be degrading either to those who were invited to join the Institute, or to those with whom it was proposed they should be amalgamated. The only object of the proposed amalgamation was to do good."

The remarks of the Professor were echoed by Mr. Jennings (also a member of the Institute), and Mr. Edwin Nash, while stating that the proposed junction of the Association with the Institute had in some respects his approval, considered that, to meet the views of both parties, a remodelling of the Institute would be necessary. Though he had paid no particular attention to the subject, the view he took of the matter was that division among the members of the profession—that was to say, dividing the body into two parts, was injurious to the profession.

Mr. Edward Hall contrasted the general feeling manifested among engineers as to the relationship between the elder and younger members with that displayed by the members of the architectural profession. "There was a disposition on the part of the elder men to give the younger credit for their works, and assistance, when required; and there was also reciprocity on the other side. Our profession, as a profession, was languishing, and that was because the profession had not been encouraged as a profession, as it ought. As to the question of education for the profession, he believed the Association had seen the importance of that more than the Royal Institute of British Architects. He thought very great advantage would result from the union of those two bodies, provided the desired advantages could thereby be secured.

Mr. Papworth supported the proposed scheme of amalgamation. He conceived that as the Association had no library, and as the Institute had a good one, that it was a matter of little difference to the Association whether they met where they were accustomed to meet, or in the chambers of the Institute, if they had the opportunity of using the library and the reading rooms, and similar advantages, without interfering at all with the regulations of the Institute, and without the Institute interfering at all with the regulations of the Association.

In the course of the proceedings the President and Chairman, Mr. Arthur Allom, read an excellent address, bearing on some of the current topics of interest, and more particularly on the architectural condition and prospects of the metropolis. Allusion was made to the growing necessity of some comprehensive measure to mitigate the serious evils contingent on our overcrowded population and thoroughfares, our smoke-laden atmosphere, and our noble river reeking with miasma. Still there is a danger of following in the unprofitable steps of past governments in expending vast sums of money in ill-digested schemes, which have the effect of permanently increasing the difficulties already to be encountered. With regard to the amount of taste hitherto exhibited in such works, it is a point that has been little considered, notwithstanding there has been a large amount of practical knowledge displayed. It had often struck him that a public committee of taste, composed of men of acknowledged ability, and perfectly accustomed to judge of works of art, would be an exceedingly useful body. How is it possible to ensure these qualifications when the men who have the management of such important affairs are from day to day liable to be displaced by others, who come to the consideration of, to them, a fresh subject, with different views and altered plans? In confirmation of his views the author referred to the bungles committed respecting the Nelson Column, and elsewhere; and spoke with warm approbation of Sir B. Hall's comprehensive plan for the New Government Offices and Westminster improvements; raising a question whether a new National Gallery should not be included in the scheme, as he took it for granted that it will not occupy the proposed site at Kensington.

Among other great works which yet remain wanting in our great metropolis, are the embankment of the Thames, the settlement of the sewage question, and the eventual appropriation of the seventy closed graveyards. After touching on several local and commercial requirements which he thought worthy of the consideration of "speculating" men, such as public dining-rooms, libraries, and the importation by railway of small blocks of building stone, at a cheap rate, Mr. Allom drew attention, in conclusion, to the immediate occasion of their meeting, enlarging on the operations and prospects of the Architectural Association; some of the allusions to which formed the basis of the addresses of the subsequent speakers, as already noted.

We may congratulate the members of the Association on so auspicious a commencement to their labours, as well as the new names just added to their list; it remains to see how far these promising beginnings will be sustained, but we have every hope, and a word of encouragement for all. Let us add, too, our repeated conviction, that on individual, rather than collective efforts, success will mainly depend.

THE ECCLESIASTICAL LAW, AS AFFECTING CHURCH BELLS.

Churchwardens are bound, at the cost of the parish, to provide a bell and rope to ring to church and toll at funerals, but it does not appear that they are bound in like manner to supply the tower with a peal. Sir W. Wynne, in "Churchwardens of Clapham *v.* the Rector thereof," gave judgment: "A ring of bells," he says, "cannot be provided for without expense, as for ropes, tuning, &c. Suppose a tone time the parishioners are willing to take upon themselves such expenses, and at another time refuse, the ordinary could not compel the parishioners to keep the bells in order because they are in the steeple. There must be a bell to ring to church and to toll at funerals, but that is all." (Prideaux-Cripps.)

Another point of ecclesiastical law is very important, and, one would suppose, should be especially remembered by the clergy, since, contrary to popular opinion, it gives them supreme command of the belfry: "Although the churchwardens may concur in directing the ringing or tolling of the bells on certain public and private occasions, the incumbent, nevertheless, has so far control over the bells of the church, that he may prevent the churchwardens from ringing or tolling them at undue hours, and without just cause. Indeed, as the freehold of the church is vested in the incumbent, there is no doubt that he has a right to the custody of the keys of the church, subject to the granting admission to the churchwardens for purposes connected with the due execution of their office. Proceedings may be instituted in the Ecclesiastical Court against churchwardens who have violently and illegally persisted in ringing the bells without consent of the incumbent. The citation may be as follows: 'For violently and outrageously breaking into the belfry of the parish church of ——, and, without leave and permission of the rector, and in defiance of his authority, several times ringing the bells in the said church.'" ("Dr. Phillimore's edition of Burn's Ecclesiastical Law, in Prideaux, 1850"). The exclusive right of the minister to the custody of the keys of the church, is clearly laid down by Sir John Nichol in "Lee *v.* Matthews."

Wherefore, if, as is often the case, the bells of the parish church are rung "without just cause;" the incumbent or minister has full power to stop them; the law wisely giving him this superintending control over the bells in his church, only if they be rung superstitiously, or at undue hours, or without just cause, that he may thus guard the interests of religion.

NOTES OF THE MONTH.

There has been so much interest excited in the Liverpool Museum and Free Public Library Competition, that we have taken some trouble to ascertain how far the result of the Committee may be deemed satisfactory; and find that it is admitted, without doubt, that the decision has been arrived at with the strictest honour and impartiality as regards individuals; and, if we are to believe our own eyes, with a considerable degree of judgment and practical knowledge. If the design chosen is carried out, it will be evidently simple, broad, compact, and characteristic, and so far will harmonise with the magnificent proportions of St. George's Hall. In the important item of expense, none of the designs prove completely satisfactory, for none can possibly be built for the 20,000*l.*; and in consequence of this, there has been a proposition to administer a measure of severe justice on the whole profession, by withholding the premiums altogether. But if it appears from the very size of the rooms required, the stipulated 20,000*l.* will be more than absorbed, it surely would be unworthy of the town of Liverpool to dismiss so unsatisfactorily professional men who have done their utmost to overcome this impossibility; and it appears to us the very compactness of "Con Amore's" plan rendered it decidedly one of the most economical. The author of the first chosen plan is Mr. Allom, of London; and of the second, Mr. Holmes, of Bury, near Manchester.

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It having been legally and finally decided that the nation's claim is good, according to Turner's will, to everything he has actually produced, the authorities of the National Gallery gave orders to hang his works during the vacation, and they will shortly be visible to the public, together with some other accessions to the gallery, The Royal Academy steps in for 20,000*l.* in hard cash, and the next of kin succeed to the engravings, plates, remainders, &c., equivalent, it is said, to something like 60,000*l.*

The first meeting of the Royal Institute of British Architects for the session 1856-7, will be held on Monday the 3rd inst. The meetings during 1856-7 will be held as follows:—1856, November 3, 17; December 1, 15. 1857, January 12, 26; February 9, 23; March 9, 23; April 20; May 4 (annual meeting), 18; June 1, 15.

Mr. Alderman Cubitt has been appointed to represent the City at the Metropolitan Board of Works in the stead of Mr. T. H. Hall, deceased.

Holford-House, Regent's-park, the appropriation of which has frequently been a matter of speculation, is to become a Baptist College—that is, Stepney College is to be removed to this new site. To complete the purchase, the sum of 8000*l.* is required, towards which 5000*l.* has been already raised. Sir Morton Peto heads the list with the munificent donation of 1000*l.* To the work of training students for the ministry, provision is to be made for receiving a limited number of lay students.

The foundation stone of a large national school, about to be erected at Chatham, in connection with St. Paul's district church has just been laid. The school will afford accommodation for a large number of children whose parents are connected with the dockyard and garrison.

The Tyne Sailor's Home, a magnificent institution, founded by the Duke of Northumberland, was opened on the 21st ult., at Shields. Business was entirely suspended, and the day dedicated to the opening of the Home. This fine building has been erected at the cost of the Duke of Northumberland, at an outlay of above 8000*l.*, the inhabitants of the district contributing 3000*l.* for its endowment. It is situated upon the New Quay, closely adjoining the river, and is a beautiful and substantial structure. The increase of the tonnage registered in the Tyne has been so great that in 1855 one-eleventh of the tonnage of the United Kingdom belonged to that river.

There are several public structures in the course of erection in Edinburgh. Robertson's School, Newington, is completed. The grounds are being laid out, and a janitor's lodge is to be erected at the entrance. The building is 74 feet in length, built of red stone, and is of Gothic design. In Cross-causeway, a new church of antique design is being built. The church of Dr. French, in College-street, is being pulled down, and the new fabric will be on a line with the street. At Fountainbridge, a territorial church was erected some time back. Some other ponderous buildings have also been added to the street architecture in this quarter. Near St. Leonard's, several blocks of houses and shops have recently been erected. In Buccleuch-street, near the Meadow entrance, a large building has been raised, containing numerous houses for the less wealthy classes. At the Grange, on the property of Sir William Dick Lauder, quite a new town is springing up, streets of villas and isolated houses.

The Goat Island Bridge at Niagara, across the east branch of the Niagara River, is situated in the rapids, about 60 rods above the cataract, on the site of the old wooden bridge. It is 360 feet long, and consists of four arches of 90 feet span each, supported between the abutments on three piers. The piers above water are built of heavy cut stone, and are 22 feet long and 6 feet wide, tapering one foot in the height. The foundations are formed of foot-square oak timber, strongly framed and bolted together in cribs filled with stone, and covered with timbers at the surface of the water. These timber foundations are protected against wear and injury from ice by heavy plates of iron, and, being always covered with water, will be as durable as the stone. The superstructure is of iron, on the plan of Whipple's iron-arched bridge. The whole width is 27 feet, affording a double carriage-way of 16½ feet, and two foot-ways of 5¼ feet each, with iron railings. The arches are of cast-iron, and the chords, suspenders, and braces of wrought-iron. The abutments and piers were erected from the designs of Mr. A. H. Porter, one of the proprietors, and the superstructure under Messrs. S. and J. M. Whipple, the patentees.

The shore north of the Huskisson Dock at Liverpool swarms with labourers, who are proceeding rapidly with the construction of a new dock of fourteen acres, a lock 100 feet wide and 500 feet long, and a square basin at the north end of the lock. The works are in an advanced state, and it is expected will be completed in less than twelve months. The masonry of the west side of the dock is finished, the lock is in a very forward condition, and the excavation of the remaining portion of the dock and the basin is being rapidly proceeded with. There are two 80-feet entrances from the south end of the new dock into the Huskisson Dock, the division being made by an island, on which a monster iron bridge, 204 feet long, will work on what is technically called a "live ring," or its own centre, so that both entrances will be opened or closed with one operation. Vessels may be thus docked or undocked with great facility; the bridge is a triumph of engineering skill, it being hitherto deemed impracticable to make a bridge longer than 80 feet to be worked with safety. It is being made on the ground, and is in an advanced state. The lock may be used as a graving-dock for large vessels, or as a principal entrance to the Huskisson Dock. The masonry, which is under the superintendence of the Messrs. Hartley, is remarkable for the beauty of appearance and solidity which are the distinguishing features of the new Liverpool Docks. The excavating is in the hands of Messrs. Brassey and M'Cormick.

A homestead has just been erected on the farm of Bucklerhole, on the estate of Rockall, on a plan which is new in that district. The whole buildings, suited for a farm of two hundred acres, are comprised in a shed 90 feet in length by 72 feet in breadth. The shed is divided into four parts by three rows of iron pillars, which support the roof. Each of these parts is 18 feet in breadth and 90 feet in length. Each part is covered with a ridge roof, one-half of slate and the other of glass, so that ample light is given through the whole interior without any windows in the walls. The outer walls and interior supporting pillars are 11 feet in height, and in addition to this there is the height of the sloping roof. Each pillar is hollow, and rain falling upon the roof descends through, and is carried off by drains below the flooring. Once within the steading there is light, dryness, and complete shelter from the weather for animals and implements. Ample ventilation is secured by openings both in the walls and roofs.

A letter from Jerusalem of a recent date, printed in the *Augsburg Gazette*, says:—"In digging out the foundations of a house which is being built in this city for the Austrian Catholic clergy, the workmen discovered, at a depth of about 15 feet from the surface, several subterranean rooms, the walls of which are of stone, and the floor of mosaic. The most important part of the discovery is, however, a grotto cut in the rock, and supported by five columns. There are certain indications which lead to a belief that this grotto had served as a church for the early Christians; but the grotto, it is supposed, was formed before the advent of Christianity. Several capitals of Corinthian (?) columns, and fragments of antique marbles have also been found. The Austrian, French, and Prussian consuls, accompanied by the architect, Endlicher, who is superintending the building, have visited these subterranean galleries, and have had photographic drawings made. The Mussulman authorities throw no obstacles in the way of these archæological researches.

A discovery of considerable interest, throwing much light upon the funeral rites of our Saxon ancestors previous to their conversion to Christianity, was accidentally made very recently at Winster, Derbyshire. While lowering a bank of earth for the purpose of making some improvements, the labourers uncovered two graves at a depth of upwards of four feet from the present surface, each containing a human skeleton, lying on its right side with the knees drawn up, and the head pointing towards the north-east. An examination of the place and the objects there discovered affords evidence of the interments having been made in the following manner: A wood fire was in the first place lighted upon the ground, in or around which some large stones were put so as to become calcined; this being burned out, the place it occupied was cleared for the reception of the body, which was then deposited in the position before mentioned, along with the implements and weapons of the deceased. The calcined stones were next piled carefully over the corpse, and finally earth was heaped up above the whole, probably while the ground was still warm. The first skeleton was accompanied by a small spear-head or knife of iron, much corroded, and the lower stone of a hand-mill, anciently used in every household for grinding

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corn; the latter had passed the fire. With the second interment was found the upper stone of the same mill, very neatly wrought in sandstone, but split to pieces by the great heat to which it had been exposed. Some pieces of a very coarse vessel of plain earthenware were found near the head of this skeleton, and behind it lay a large spear-head of iron, 2 ft. 10 in. long, a curved instrument of the same metal, 5 inches, originally fixed in a wooden handle, the bone ferule of which still remains, and a ring-like bead or decoration of light-coloured porcelain, about 1½-inch in diameter. The whole of the articles exhumed from these graves (which may be assigned to the Teutonic or iron period, including the time from the end of the fifth to the eighth century) have been deposited in Mr. Bateman's museum of antiquities, at Lomberdale House.

At the October meeting of the Society of Antiquaries, Newcastle-on-Tyne, Dr. Bruce read a paper on the Roman Wall from the Forth to the Clyde, which has been all but obliterated by the modern works of canal and railway. Dr. Bruce, after pointing out minute particulars and drawing comparisons betwixt the work (of Antoninus) and the other north country Roman wall (by Hadrian), stated that tradition still points to the time when, not more than 140 or 150 years ago, it was the only channel of direct communication between Newcastle and Carlisle. The remains of some of the stations are still very distinct, especially at Barr Hill, at Kirkintilloch, and at Castle Hill. Barr Hill is near the centre of the line, and its summit is the highest between the two seas. It commands an extensive view of a very bleak and desolate region. The belt of country occupied by the wall is on the whole flat, but a number of small basaltic hills seem to play around this central summit like the short and broken waves of an angry sea. Here was an immense swamp called the Dollater Bog, to the north of the wall. The entrenchments of the camp are boldly marked on the summit of the hill, and remains of buildings within them are still to be seen. But the most remarkable feature of this part of the line is the fosse of the dyke. It is cut, in all its dimensions (40 feet broad and 35 deep), out of the solitary trap rock.

At the meeting of the Asiatic Society of Bengal on the 6th August, Major Thuillier announced that Colonel Waugh, Surveyor-General of India, had completed his computations of the positions and elevations of the peaks of the Himalayas. The result was to depose the mountain Kanchinjinga from its throne as the highest point on the earth's surface. That distinction belongs for the present to a peak 100 miles from Kanchinjinga, and between that mountain and Katmandoo. This peak is ascertained to be 29,002 feet above the sea level; Kanchinjinga is 28,156 feet, and Dewalagiri, the mountain which "school geographies" persist in calling the "highest in the known world," is only 26,826 feet. The mountain has no name intelligible to civilised men, and Colonel Waugh has therefore ventured to denominate it "Mount Everest," after a former surveyor-general. A special report on all these peaks will shortly be forwarded to England.

The safe arrival at the Mauritius is announced, on the 13th of August last, of that celebrated African explorer, Dr. David Livingston. He has at length succeeded in accomplishing that so often, by the white man, in vain attempted feat—the traverse of Africa from ocean to ocean; having, besides the discovery in 1849 of lake Ngami, in company with Messrs. Oswall and Murray, and other journeys since in various directions, actually penetrated from the Cape north and west to Angola, whence he returned as far as Lesheké, and thence finally eastward to Teté and Quilimane on the East coast. Now that the Count D'Escayrac de Lature, with the great Egyptian expedition, is from Cairo about steaming up the Nile, and Captain R. Burton has departed, under the auspices of the Royal Geographical Society, on his exploration to Zanzibar, it is earnestly to be hoped that Dr. Vogel, who, with his attendant, Corporal Maguire, has so long perambulated the comparatively well-known countries to the west of Lake Chad, may at length direct his steps to the hitherto unexplored lands between that lake and the Indian Ocean. As far back as 1854 he wrote to Germany, to the effect that he only waited the receipt of 200*l.* more from the British Government, in order to proceed at once to Wadai, and then "the Indian Ocean for ever." This sum must have long since been received, and the worthy doctor and his companion may possibly be at present *en route* for the sources of the Nile.

A company is in course of formation under the name of the "London and Shoreham Great Ship Canal Company," having for its object the transporting of vessels of whatever tonnage, by means of a canal, directly to or from Shoreham and London; thereby avoiding the present risk, delay, danger, and expense consequent upon vessels arriving in the Channel having to go round the Foreland. The number of vessels that are yearly lost or sustain serious injury in the Downs, off the Foreland, or on the Goodwin and Margate Sands, is of itself a sufficient warranty for an undertaking like the present, which, if carried into effect, will entirely obviate these dangers, involving a loss annually of a million sterling.

By the invention of Ruston's Tubular Anchor, elasticity is given to the anchor shank, which is enclosed in a tube, a helical spring being interposed, rendering the anchor capable of resisting those strains and violent jerks to which vessels are subjected when opposed to strong winds. A further yielding power is given by means of spring appendages in the ship; thus both anchor and cable give elasticity simultaneously. The great losses annually in anchors and cables, render this invention an object of great importance to shipowners and others. The models may be inspected at the offices of the inventor, in Fenchurch-street.

The works of the Seville and Cordova Railway are in a state of great forwardness, attributable to the zeal of its engineers and directors, Messrs. Lamiable and Dubreux. M. Denis, an engineer and representative of the company, lately inspected the line, which he found in excellent condition, and a commission of the municipality had been appointed to come to an understanding with the engineers of the company respecting the construction of the terminus.

On the 22nd Sept. the Emperor of Austria signed a so-called pre-concession (*vorlaufige concession*) for the great Transylvania railroad. The concessionaries are Baron Rothschild, the Duke of Galliera, and Messrs. Laing and Uzielli, and the line of railroad which they will have to construct is from Arad in the Banat, by way of Hermannstadt and Kronstadt, to the Wallachian frontier. The same company is also likely to obtain a concession for a railroad from Arad, by way of Sissek in Croatia, to Fiume.

OBITUARY.

On September 7th, Mr. John Paull, aged twenty-seven years, mining engineer, and recently appointed manager of Fort Bowen Gold and Silver Mines, near Chagres, Central America. He was son of the late Mr. Paull, of Tavistock, tin smelter and mining engineer. At nineteen years of age, after making himself familiar with the mining districts of this country, he went to Australia, where he successfully carried on copper mining. From thence he went to California, and applied himself to gold mining. He was buried in the cemetery at Colon.

On September 24th, Mr. Henry Watson, C.E., aged thirty-eight years. At the age of nineteen Mr. Watson was appointed locomotive engineer to the Manchester and Birmingham Railway, and afterwards filled successively the following situations, viz.—locomotive engineer to the Eastern Counties, the Chester and Birkenhead, and the East Lancashire railways. In 1848 he was appointed London agent to the Bowling Iron Company; and in 1852 inspector of the rolling stock manufactured in England for the Great Indian Peninsular Railway Company.

On September 25th, Mr. J. Ashby, in attempting to board a steamboat, missed his footing, fell into the river, and was drowned. He for several years discharged the onerous duties of a clerk of the works at the New Houses of Parliament.

Recently, at his residence in Finsbury-square, London, after a short but severe illness, Mr. Thomas Henry Hall, late chairman of the City of London Improvement Committee, and member of the Metropolitan Board of Works, aged sixty-five years. He entered the corporation in 1829, for the ward of Coleman-street, which he represented for 27 years. In 1848 de was elected chairman of the "Improvement Committee," and during his time some most important works have taken place, such as the formation of Cannon-street West, and the extension of the New Farringdon-street to Clerkenwell. In December last, Mr. Hall was chosen a representative of the City at the Board of Works, with Deputy Harrison and Mr. H. L. Taylor.

On October 10th, John Wood, Esq., chairman of the board of Inland Revenue,—a warm supporter of the London Society of Arts.

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COMPETITIONS.

The Burial Board of the Parish of Aylesbury are desirous of receiving plans and designs with specifications and estimates, comprising ground plans, sections, and elevations, for laying out, planting, and fencing a New Burial Ground, and building a lodge and two chapels thereon. The ground contains four acres, a plan of which may be seen, and further information obtained at the Office of the Board. The Board will not be bound to employ the person whose designs, plans, or drawings may be adopted; but in the event of his not being employed, will pay him a premium of ten guineas, the designs, &c., to become the property of the Board. The plans and designs to be sent to Mr. R. M. Benson, Clerk to the Board, by the 7th of November.

Plans and Specifications are invited for the New Workhouse, and Buildings to be erected at Foleshill, Warwickshire, with accommodation for 150 paupers. Particulars will be forwarded on application to Mr. Thos. Dewes, Clerk to the Board of Guardians of Foleshill Union, Coventry. Plans to be sent in by the 24th of November.

The Scarborough Cliff Bridge Company are desirous of procuring designs for enlarging and otherwise improving the Spa Saloon, accompanied with detailed working drawings, specification, and estimate. The Concert-room is to be made sufficiently large to accommodate 2000 persons, exclusive of an orchestra for fifty performers, with two retiring rooms, and other conveniences. The company will award to the author of the best design in their judgment, the sum of 40*l*., and to the author of the second best design, the sum of 20*l*. Designs and specifications for which premiums are awarded will become the property of the company, who will not bind themselves to employ the author to superintend the carrying out of the works. The company will not pay either of the premiums unless a sufficient tender be made for the actual execution of the works within the amount of the author's estimate. The designs must be deposited with Mr. Robert Ward, the Secretary to the Cliff Bridge Company, Scarborough, by the 29th of November.

The authorities of the borough of Linkfield, Reigate, Surrey, require plans for the laying of sewers, with levels, sections, &c., the whole to be clearly defined and laid down to a scale of one chain to the inch. The following premiums are offered: for the plan adjudged the best by the Committee, 20*l*.; for the second best 10*l*. The plans to which the above premiums shall be awarded will be retained by, and be the property of the local authority. Particulars may be obtained of Mr. F. Bonny, Inspector, Station-road, Redhill. Plans to be sent in by the 1st of December.

The Trustees for sale of a Freehold Estate of 500 acres, including the Beulah Spa, and near the Crystal Palace, require Plans for Laying Out the same for building purposes, showing the necessary roads, sewers, &c., the whole to be clearly defined and apportioned in suitable lots, and laid down to a scale of two chains to one inch, from actual admeasurement. The premiums offered are, for the approved plan, 150 guineas; for the second, 100 guineas; for the third, 50 guineas. Particulars may be obtained of Mr. Peacock, builder, near the Jolly Sailor Station, Norwood. The plans are to be forwarded to the Secretary's office, Auction Mart, London, addressed to the Trustees of the White Horse, Norwood Estate. The time for receiving them is extended to the 8th of December.

A Premium of 100*l*. is offered for the best Essay on the present condition and future prospects of Canals and Canal Conveyance. Essays to be sent in to Mr. Thomas Wilson, Honorary Secretary to the Canal Association, Aire and Calder Navigation Office, Leeds, to December 31.

The Committee for carrying out the erection of the Memorial Church at Constantinople, wish to receive designs for the same. The style to be adopted must be a modification to suit the climate, of the "Pointed" or Gothic. The church to be of sufficient capacity to hold, without galleries, seven hundred persons, and the cost not to exceed 20,000*l*. Premiums, 100*l*. for the first, and 70*l*. and 50*l*. for the second and third, or in case of equality, two prizes of 50*l*. The Designs to be sent to the Honorary Secretaries of the Memorial Church, No. 79, Pall-mall, not later than January 1st, 1857.

The Commissioners of Her Majesty's Works and Public Buildings invite architects of all countries to furnish them with designs for Offices for the Secretary of State for Foreign Affairs, for the Secretary of State for War, and for laying out the ground between the Thames and St. James's-park, adjoining Great George-street. The drawings to be made to a scale of 16 feet to the inch. General specifications of the materials proposed to be used in the buildings must accompany each design. A block-plan showing how the site may be so appropriated that the two buildings proposed to be erected may form part of a large and comprehensive scheme for concentrating the principal public offices, and for the improvement of the leading thoroughfares, including Westminster-bridge, whether as regards its present or any other site. Seven premiums for the best designs for the War Office of 800*l*., 500*l*., 300*l*., 200*l*., 100*l*., 100*l*., and 100*l*. Seven premiums for the best designs for the Foreign Office, of 800*l*., 500*l*., 300*l*., 200*l*., 100*l*., 100*l*., and 100*l*. For the best design for a block plan, three premiums of 500*l*., 200*l*., 100*l*. Plans of the ground, and other particulars will be forwarded on application to Mr. Alfred Austin, Office of Works, Whitehall. Designs to be sent in by the 20th of March.

Designs are invited from artists of all countries for a Monument to be erected in St. Paul's Cathedral, to the memory of the late Duke of Wellington. The cost, with all expenses, not to exceed 20,000*l*. Premiums of 700*l*, 500*l*., 300*l*., 200*l*., and five of 100*l*. A ground-plan of the cathedral, and the site of the proposed monument, &c., will be forwarded, on application to Mr. Alfred Austin, Office of Works, Whitehall. Designs from artists residing in the United Kingdom to June 1st, 1857; from artists residing abroad to the 25th of the same month.

The Burial Board of St. Helens have selected the designs of Mr. Thomas D. Barry for the erection of the three chapels, lodges, &c., and also for laying out the Cemetery Grounds.

The designs of Mr. Clement Way, of Newport, have been selected by the Carisbrooke Burial Board for the two chapels, lodge, and boundary walls for enclosing the new burial-ground at Hanger's-hill. The estimated cost is 1500*l*.

The Town-council of Liverpool have awarded the first prize of 150 guineas, for the design for the Free Library, and Museum to Mr. Thomas Allom, of St. Martin's-lane, London; and the second prize of 100 guineas, to Mr. T. Holmes, of Bury, Lancashire.

The Burial Board for the parish of Brighton have adopted the designs of Mr. R. Wheeler, for the chapels, &c., on the new burial-ground, which designs have received the sanction of the Secretary of State and the Bishop of the Diocese.

The plans of Messrs. Haden, of Trowbridge, for warming and ventilating the Town-hall, Leeds, have been adopted by the Town-council.

NEW PATENTS.

PROVISIONAL PROTECTIONS GRANTED UNDER THE PATENT LAWS AMENDMENT ACT.

Dated July 18.

1690. W. Leuchars, Piccadilly—Improvements in locks for travelling bags

Dated August 21.

1954. W. Heap, D. Sharp, and G. Knowles, Bradford—Improvements in the construction of furnaces for economising fuel and preventing smoke

Dated August 25.

1982. G. Warriner, Withernsea, York—Improvements in compounds for preserving, deodorising, and fertilising

Dated August 26.

1992. A. V. Newton, Chancery-lane—An improvement in breech-loading cannons and other ordnance. (Communication)

1993. S. Jay and G. Smith, Regent-street—Improved facing or covering to be attached to the outside of ladies' dresses, mantles, or other articles of attire, peculiarly adapted for the warmth and protection of the chest

Dated August 27.

1995. J. M. Giresse, St. Macaire, France—A new machine to mince tallow and meat

Dated August 30.

2017. A. L. A. Herbelot, Paris—Improvements in obtaining motive power by gases or fluids

2019. J. Pope, Canterbury—Improvements in the mode of cultivating and treating the hop plant

Dated September 4.

2049. J. Picken, Dunlop, Ayr—Improvements in the arrangement of the feed apparatus of machines for thrashing or separating grain

Dated September 6.

2074. H. Dyer, Plaistow, Essex, and G. Dyer, Gracechurch-street—Improvements in freeing textile fabrics, cotton waste, and fibrous matters from oily and other impurities

2076. S. W. Park and E. S. Ells, Troy, New York, U.S.—Improvements in machinery for knitting tubular fabrics

Dated September 9.

2097. J. Watson, Tureen-street, Glasgow, and C. F. Halle, Manchester—Improvements in spinning or twisting fibrous materials

2099. H. Cunningham, Pitarthie, Fife—The production of blanks for bank notes, bills, checks, treasury bonds, scrip, stocks, &c., to prevent counterfeiting, &c.

2101. R. A. Brooman, Fleet-street—An improvement in an apparatus for sprinkling substances in a state of powder. (Communication from F. H. Ouin)

2105. W. Smith, Salisbury-street, Adelphi—A powerful compound whistle. (Communication from L. Pinel, Rouen)

Dated September 10.

2106. H. Cooke, Manchester—Improvements in dyeing yarns and threads

2107. C. W. Siemens, John-street, Adelphi—Improvements in electric telegraphs and apparatus. (Communication)

2108. A. Robert, La Villette, near Paris—A new process of treating, smelting, and refining copper, tin, and other refractory metallic ores

2109. H. D. P. Cunningham, Gosport—Improvements in reefing sails

2110. G. Riley, The Grove, South Lambeth—An improved mode of treating maize for distilling, with apparatus therefor

2111. J. Neuenschwander, canton of Bern, Switzerland—Improved processes of preparing milk to be preserved

2112. H. Gilbee, South-street, Finsbury—Improvements in the manufacture of iron. (Communication)

2113. J. Taylor, Spring-grove, Hounslow—An improvement in building walls

2114. J. C. Davidson, Yalding, Kent—An improved construction of share drill

2115. S. White, Newlands-street, Liverpool—An improved method and apparatus for the distillation of certain oils or oily substances from the petroleum, commonly called earth oil, found in certain districts in the Birman empire, and an improved method of purifying the oils or oily substances so obtained

2116. J. C. Davidson, Yalding, Kent—An improved construction of hop bin or hop frame

2117. W. Webster, Bunhill-row, Finsbury—Improvements in troughs for feeding animals. (Partly a communication)

2118. J. H. Johnson, Lincoln's-inn-fields—Improvements in machinery or apparatus for making bricks. (Communication from J. Harman, U.S.)

2119. W. Oldham, Southam, Warwick—Improvements in the manufacture of cement, and in treating or preparing colouring matter for cements

2120. W. H. Forster, Gravesend—An improved fastening for articles of jewellery, brooches, or dress ornaments

Dated September 11.

2121. J. B. Robinson, Beverley, York—Improvments in machinery for effecting agricultural operations. (Communication)

2122. J. Gedge, Wellington-street South, Strand—Improvements in paint or colouring matter applicable to coating metals and other substances, whereby the oxidation of metal is prevented, and resistance to the action of the atmosphere, rays of heat, or acids, is secured. Communication from A. Macpherson, Brussels)

2123. J. Hudson, Halifax—Improvements in whetting or setting printers' doctors, and other straight-edged tools or instruments

2124. P. A. Balestrini, Brescia, Italy—Improvements in protecting and laying telegraphic wires

2125. R. A Coward, Lawrence Pountney-lane—Improvements in paddle-wheels for propelling vessels. (Communication)

2126 J. Milnes and W. Thompson, Sutton Mill, Kildwick, York—Improvements in looms for weaving

2127. L. E. Truesdell, Warren, Massachusetts—An improvement in weight-distributing bridges

2129. A. Chaplain, Glasgow—Improvements in ships or vessels

2130. A. D. Bishop, Hanover House, Charlton, Kent—Improvements in derricks for raising sunken ships and other heavy bodies from below water, and moving heavy bodies from one place to another

Dated September 12.

2132. W. S. Clark, Camden-town—Improvements in hydraulic heaters or furnaces. (Communication from L. W. Leeds, Philadelphia, U.S.)

2133. J. J. Leaver, York-street, Rotherhithe—An improved pump for pumping, raising, or forcing water or other liquids

2134. J. T. Pitman, Gracechurch-street—Improvements in repeating fire-arms. (Communication)

2135. J. Koronikolski, Lisle-street, Leicester-square—Improvements in baking-ovens

2136. H. Dubs, Vulcan Foundry, Warrington, and J. Evans, Haydock, Lancaster—Improvements in slide valves

2137. E. Paton and C. Walsh, Perth—Improvements in fire-arms and projectiles

2138. I. Leys, South-street, Finsbury—Improvements in the preservation of cheese

2139. G. Hutchison, Hope-street, Glasgow—Improvements in the treatment of oils and fats

2140. J. Elliott, Southampton—An improved apparatus for containing and supplying water, gas, and other fluids, applicable also to a fluid meter

2141. R. A. Brooman, Fleet-street—Improvements in treating and purifying water to be used in the washing and scouring of wool, and in other washing and cleansing operations. (Communication)

Dated September 13.

2143. W. Whittle, Smethwick, Stafford—New or improved machinery for the manufacture of nails

2144. R. Peyton, Birmingham—An improvement or improvements in the manufacture of metallic bedsteads and other articles for sitting, lying, and reclining upon

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2146. J. S. Vaughan, Stockland Vicarage, near Bridgewater—An improvement or improvements in the apparatus for making infusions of vegetable or other substances.
2147. F. D. Monod, Marseilles, France—Improvements in the manufacture of chlorine
2148. R. A. Brooman, Fleet-street—Improvements in mills. (Communication)
2149. C. Hill, Great Western Railway, Chippenham Station—Improvements in the manufacture of lubricating matters
2150. S. C. Lister, Manningham, near Chester—Improvements in preparing and spinning cotton, flax, and similar fibres
2251. J. Buchanan, Katrine, Ayr—Improvements in propelling vessels

Dated September 15.

2153. J. Knowelden, Southwark, Surrey—Improvements in the arrangement of valves and apparatus for preventing steam-boiler explosions
2154. J. B. J. Lassie, Rue de l'Echiquier, Paris—A new system of aerial navigation
2155. C. F. Clements, Liverpool—An improvement in separating copper and other metals from ores containing them
2156. C. Kline, Brooklyn, New York—The improvement of mariners' and other compasses, by which the effect of local attraction is cut off or neutralised, and the compass is made to traverse more perfectly
2157. G. C. T. Canstoun, Chirnside Bridge, Berwick, G. Young, Dunse, Berwick, and J. Lovell, Chirnside Bridge, Berwick—Improvements in the application of steam for producing a boiling action in bleaching and other manufacturing processes
2152. A. Rowand, Glasgow—Improvements in cases or vessels for holding gunpowder
2159. S. Chodzko, Paris—Improvements in the manufacture of manure and the apparatus employed therein

Dated September 16.

2160. R. E. Garrood, Chelmsford—Improvements in stopcocks and valves for the drawing off and passage of air, gas, steam, water, and other fluids, or for any other purpose for which the same may be applicable
2161. A. V. Newton, Chancery-lane—An improved preparation of phosphoric acid. (Communication from E. N. Horsford, Massachusetts)
2162. A. V. Newton, Chancery-lane—Improved apparatus for raising water by atmospheric pressure. (Communication from Delettrez Perć and Co., Passy, France)
2163. R. Walker, jun., Buchanan-street, Glasgow—Improvements in acertaining the draught of water and trim of ships or vessels
2164. R. Lavender, Aldersgate-street, and E. Lavender, Aston-street, Limehouse—Improvements in raising water and other fluids, and in obtaining power thereby
2165. G. T. Bousfield, Sussex-place, Loughborough-road, Brixton—Improvements in power looms for weaving wire cloth. (Communication)
2166. R. A. Brooman, Fleet-street—Improvements in water-closets and night-stools. (Communication from P. Saroglia and V. Belli)
2167. J. Elliot, Southampton—An improvement in taps and cocks
2168. R. Mushet, Coleford, Gloucester—Improvements in the manufacture of iron
2169. R. Mushet, Coleford, Gloucester—Improvements in the smelting of iron ores
2170. R. Mushet, Coleford, Gloucester—Improvements in the manufacture of iron
2171. J. G. Martien, Newark, New Jersey—Improvements in the manufacture of iron

Dated September 17.

2172. R. Burns, Liverpool—Improvements in bone mills
2173. C. Marsden, Kingsland-road—Improvements in fastenings for shirts and other garments, together with an improved tag
2174. D. Crichton and J. Cathcart, Manchester—Improvements in looms for weaving
2175. J. Barber, Manchester—Improvements in machinery or apparatus for mill and other engraving, punching, dividing, and ruling rollers, either for hand or machine engraving, and an improved mandril used in mill, eccentric, and other machinery employed in engraving rollers for printing and embossing calicoes and other fabrics
2176. A. Andraud, Paris—Certain improvements in wheelbarrows
2177. W. F. Spittle, Birmingham—A new or improved spindle for braiding or plaiting machines
2179. C. H. Schröder, Altona, Holstein—An improved rotatory engine, to be worked by steam or other elastic fluid, which invention is also applicable as a rotatory pump for raising and forcing liquids
2180. G. Davies, Serle-street, Lincoln's-inn—Improvements in apparatus for actuating railway breaks. (Communication from J. Häberlein, Munich)
2181. F. H. R. Scheller, Vienna—An improvement in the manufacture of illuminating gas
2182. J. M. Hetherington and J. Gee, Manchester—Improvements in flyers for preparing cotton and other fibrous substances for spinning

Dated September 18.

2183. I. Baggs, Manchester-street, Argyle-square—Improvements in smelting or reducing copper and other metals from their ores, and in the manufacture of sulphuric acid in or by such processes
2184. T. C. Hinde, Birmingham—An improvement or improvements in the manufacture of iron
2185. T. Horrex, South-square, Gray's-inn—Improvements in means or apparatus to facilitate the delivery of coals to cellars and other such places
2186. L. Jacquemier, Charlotte-street, Fitzroy-square—Improved method of hardening and colouring alabaster and other gypsums, and calcareous stones and earths. (Communication from the Marquis Campana)
2187. G. Hill, City-road, Derby—Improvements in feeding steam-boilers
2188. A. G. Guillaumin, Paris—An improved ramrod
2189. R. Wilson, Oxford-court, Salter's-hall—Improvements in the construction of fire-proof floors and ceilings, applicable in part to the construction of bridges and other structures
2190. W. F. Plummer, St. Mary's Overy Wharf, Southwark—An improved mode of preparing hard wheat and other hard grain for grinding
2191. T. Greenwood, Leeds—Improved machinery for trimming the teeth of wheels
2192. W. H. Cooper, Manor Cottages, Bromley Hall—An improvement in the manufacture of fretwork for ornamental windows or lights, applicable also to the cutting of irregular figures in glass generally
2193. C. Goodyear, jun., Leicester-square—Improvements in the manufacture of penholders and handles for penholders

Dated September 19.

2194. J. B. H. de Roussen, Rue de l'Echiquier, Paris—Improved apparatus for washing and cleansing ores
2196. C. F. Vasserot, Essex-street, Strand—Improvements in filtering water on a large scale. (Communication from H. Darcy, Paris)
2197. J. Smale, Gibraltar-row, Southwark—Improvements in the mode, means, or apparatus for printing or transferring designs or letters on to glass
2198. P. Laffitte, Paris—An improved engine with rotary piston, applicable to various purposes
2201. A. Clarke, High-street, Southampton—Improvements in signal lamps
2202. W. Young, Queen-street, Cheapside—Improvements in furnaces, fire-places, and stoves
2203. E. Finch, Bridge Works, Chepstow—Improvements in the construction of wrought-iron masts, bowsprits, yards, booms, gaffs, and spars, and in rigging ships
2204. G. Dawes, Union-street, Southwark—Improvements in the manufacture of hats
2205. R. Van Hees, Manchester—Improvements in the construction of electric clocks or time-keepers (Communication from R. Kamerer, Ostend)

Dated September 20.

2207. J. Sherah, Aberdeen—Improvements in oil and spirit lamps by the formation of burners obviating shadow
2208. R. Van Hees, Manchester—Improvements in the construction of wrought-iron wheels for railway and other purposes. (Communication)
2209. J. Naylor, Birmingham—Improvements in window fastenings
2210. W. Johnson, Lincoln's-inn-fields—Improvements in steam-boilers. (Communication)
2211. W. E. Cochrane, Osnaburgh-terrace, Regent's-park—An apparatus for converting crude iron while in a fluid state from a blast or other furnace into malleable or bar iron and steel
2212. J. Maudslay, Lambeth—Improvements in fire-places for steam-boilers
2213. T. W. Rammel, Trafalgar-square—Improvements in constructing railways and propelling carriages thereon
2214. J. Roberts and J. Beech, Walsall, Stafford—A new or improved railway chair
2215. A. Ford, Chelsea—Improvements in dissolving vulcanised india-rubber for waterproofing and like purposes
2216. G. W. Sayer, Mark-lane—Improved machinery for stopping or retarding railway carriages. (Communication from H. Malepart, Cognac, France)
2217. T. E. Blackwell, Clifton—Improved mode of constructing fire-flues and air-passages

Dated September 22.

2218. W. Taylor, Woodhall Cottage, Shipborne, Tunbridge—Improvements in the conversion of cast-iron into steel and malleable iron
2219. R. Mushet, Coleford, Gloucester—Improvements in the manufacture of iron and steel
2220. R. Mushet, Coleford, Gloucester—Improvements in the manufacture of iron and steel
2221. W. B. Sellers, and A. Sellers, Sheffield—Improvement in "ever-pointed" pencil cases
2222. J. Wilson and C. Wootton, Birmingham—A new or improved screw-wrench. (Communication)
2223. J. Morrison, Birmingham—A new or improved pen-holder
2224. T. Wallace, Limehouse—Improvements in the manufacture of wheels, axles, and axle-boxes

Dated September 23.

2225. J. G. Taylor, Glasgow—Improvements in fastenings, connectors, and couplings, and in the application thereof
2226. D. O. Boyd, Welbeck-street—Improvements in constructing and arranging flues, for the passage of air or smoke.
2227. F. Wrighley, Long Island Iron Works, Carlisle—An improved friction coupling for the transmission of motive power
2228. R. Winterbottom, jun., Staleybridge, Lancaster—Improvements in the mode or method of making or producing dry barm or yeast
2229. R. Husband, Manchester—Improvements in the manufacture of silk hats
2230. A. V. Newton, Chancery-lane—Improvements in gimlets, augers, and other tools which operate by a rotary motion. (Communication)
2231. W. Johnson, Lincoln's-inn-fields—Improvements in machinery for doubling and twisting fibrous materials. (Communication from E. Weber)

Dated September 24.

2232. A. G. Baylis and J. Green, Redditch, Worcester—An improvement or improvements in the manufacture of needles
2233. A. Barrie, Edinburgh—A new or improved instrument or apparatus for registering the time at which workmen arrive at and leave their place of work, and for other such like purposes
2235. J. Cottrill, Studley, Warwick—Improvements in machinery to supersede hand labour in the operation of filing.
2236. A. V. Newton, Chancery-lane—Improvements in carding engines. (Communication)
2237. P. W. Barlow, Great George-street, Westminster—Improvements in the permanent way of railways
2239. W. Beatson, Chemical Works, Rotherham——Improvements in puddling iron
2240. C. Vion, High Holborn—Improvements in metallic moulds, and in the manner of using them for casting metals. (Communication from J. Boy, Paris)
2241. V. F. A. Prost, Paris—Improvements in weaving and in the machinery or apparatus employed therein

Dated September 25.

2242. R. Brown, Glasgow—Improvements in taps or valves
2243. T. Holmes and T. Aspinall, Pendleton, Lancaster—Improvements for preventing or diminishing the production of smoke in fire-places and furnaces, and for effecting its combustion
2244. J. W. Wilson, Banbury, Oxford—Improvements in machinery or apparatus for manufacturing parts of brooms and brushes
2245. C. Sayno, Novara, Piedmont—Improvements in bearings, beds, or sockets for axles, pivots, or other rotary parts of machinery
2247. F. Sabatier, Paris—Improvements in the permanent way of railways
2248. H. W. Parnell, Bryanston-square—The construction of ships and boats
2249. A. Albright, George-street, Edgbaston, Warwick—Improvements in the manufacture of lucifer-matches, and of boxes suitable for containing the same
2250. R. Frost, Steam Mills, Chester—Improvements in the manufacture of flour
2251. J. J. Russell, Wednesbury, and J. B. Howell, Sheffield—Improvements in the manufacture of cast-steel tubes
2252. M. A. Muir and W. J. Walker, Glasgow—Improvements in machinery or apparatus for sizeing or dressing yarns or threads
2253. S. Calley, Brixham, Devon—Improved composition and compositions for coating or covering surfaces, particularly the bottoms of ships and vessels

Dated September 26.

2254. C. Laoglois, Bath—Improvements in photography
2255. J. F. Meakin, Baker-street, Portman-square—Improved fire-escape
2256. M. Pellen, Rue d'Anjou St. Honoré, Paris—Rendering impermeable by gas, caoutchouc, gold-beaters'-skin, paper, gauze, and similar materials used for things adapted to receive an ascending force, such as balloons, aerostatic machines, toys, &c. by the application of a peculiar varnish
2257. C. Renshaw, Dukinfield, Chester—Improvements in squeezing rollers, applicable to machinery or apparatus for pressing or partially drying yarns and woven fabrics
2258. W. Horsfall, Manchester—Improvement or improvements in cards for carding fibrous substances
2259. G. G. Woodward, Kidderminster—Improvements in the manufacture of carpets
2260. F. Ransome, Ipswich—Improvements in the manufacture of artificial fuel

Dated September 27.

2261. J. Holland and J. Irving, Manchester—Improvements in the treatment of certain waste woollen yarns or threads, whereby the fibre or wool of which they are composed is rendered capable of being again spun and manufactured
2262. D. Thom and G. A. Phillips, Manchester—An improvement in soap frames
2263. G. Neall, Northampton—An improved union gas stove for lighting and heating
2264. J. Boyd, Ashbocking, Suffolk—Improvements in letter-press printing machines
2265. W. Smith, Skinner-street, Snow-hill, and N. F. Taylor, Stratford, Essex—Improvements in apparatus for measuring gas and other fluids, and in regulating the flow of the same

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2267. F. Ransome, Ipswich—Improvements in the manufacture of artificial stone, and in rendering it and other building materials less liable to decay
2268. J. M. Hayes, Portland-terrace, Southsea—Improvements in percussion cap holders
2269. J. Edwards, Liverpool—An improved ships' log (Communication)
2270. J. Rothwell, Park-hill, Bolton, Lancaster—A certain composition and preparation to promote the ignition and combustion of coke, coal, and other combustible substances in stoves, furnaces, and grates
2271. J. Ormerod, Salford, Lancaster—Improvements in machinery or apparatus for bleaching and washing or cleansing textile fabrics and materials, applicable also to the "soaping of printed fabrics"

Dated September 29.

2272. L. D. Jackson, Underwood, Selstone, Nottingham, and H. Myers, Rathbone-place—An apparatus for the better working of breaks in stopping railway trains
2273. J. F. V. Larnaudès, Rue Gabrielle, Montmartre, near Paris—An anti-putrifactive and disinfectant
2274. C. J. Carr, Belper, Derby—Improvements in operating hammers and stamps
2275. J. N. Ward, United States—An improvement in the construction of self-priming fire-arms
2277. M. Hickson, Salford, Manchester—Improvements in waterproofing certain woven fabrics
2278. D. Thom and G. A. Phillips, Manchester—Improvements in apparatus used in the manufacture of soap
2279. R. Morrison, Newcastle-upon-Tyne—Improvements in the construction of apparatus for lifting, lowering, hauling, and removing moveable articles by the direct action of either water, steam, or gaseous vapour.
2280. J. Lord, Rochdale—Improvements in the process of separating or recovering animal wool or silk from cotton and woollen or from cotton and silk or other mixed fabrics, whereby the animal wool or silk is rendered capable of being again employed, which said improvements are also applicable to wool in its unmanufactured state
2282. G. T. Bousfield, Sussex-place, Loughborough-road, Brixton—An improvement in the manufacture of artificial stone. (Communication)
2283. C. W. Ramié, Pimlico—Improvements in constructing the permanent ways of railways

Dated September 30.

2284. S. Ivers, Halshaw Moor, near Bolton-le-Moors, Lancaster—Improvements in looms for weaving
2285. T. A. Dillon, Dublin, and J. Gray, Princes-street, Dublin—An improved means for making signals on railway trains between the guard and driver respectively, and between the passengers and guard and driver, and of giving notice to the guard and driver in case of the accidental severance of the parts of a train; which invention is applicable also to steam ships, factories, and other places where it may be requisite to communicate with distant points
2286. R. Ross, Glasgow—Improvements in paddle wheels for propelling apparatus for ships or vessels
2287. S. Jay and G. Smith, Regent-street—A new material to be employed in the manufacture of bonnets, hoods, hats, or caps
2288. W. G. Gard, Calstock, Cornwall—Improvements in bits for boring and sinking
2289. D. Bruce, Paspebiac, Bonaventure, Canada—Making a concentrated anima manure

Dated October 1.

2291. C. L. H. Quentin, Rue des Petits Hotels—Making a new kind of artificial millstones
2292. G. Flint, Skinner-street, Bishopsgate Without, and T. Wood and E. Wood, Tachbrook-street, Pimlico—An improved punching press or machine, adapted to the purposes of stamping, coining, slotting, and embossing, and for cutting metal and other substances.
2293. J. Dauglish, Great Malvern, Worcester—An improved method of making bread.
2294. J. Holman, Western Clubs, Topsham—Improvements in ships' rudders.
2295. J. Begg, Glasgow—Improvements in preparing and bleaching textile fabrics and materials.
2296. H. Naylor, Bacup, Warper, and J. Crabtree, Rochdale—Improvements in and applicable to machines commonly known as "warping mills"
2297. J. Pateson, Linlithgow—Improvements in the manufacture of paper
2298. A. V. Newton, Chancery-lane—Improvements in sewing machinery. (Communication)
2299. R. G. Salter, Alphington, Devon—A method of an apparatus for expediting the stamping or marking of letters, papers, labels, and documents, and improvements in and additions to stamping and marking instruments or apparatus, or in connection therewith
2300. C. D. Gardissal, Bedford-street, Strand—Improvements in stoves and apparatus for heating or warming greenhouses, which may also be used for other warming or heating purposes (Communication)
2301. C. D. Gardissal, Bedford-street, Strand—An improved construction of pump. Communication)
2302. D. Jones, Greenhill Villa, Ragland, Monmouth—Improvements in obtaining and motive power
2303. E. Wilcox, Harmston, Lincoln—Improvements in pumps

Dated October 2.

2305. E. Hardon and J. Henry, Stockport, Chester—Improvements in looms for weaving, and in machinery for communicating motion to looms and other machines
2306. J. Whitehead, Dukinfield, Chester—Improvements in machinery or apparatus for preparing and spinning cotton and other fibrous substances
2307. J. Renshaw, Salford, Lancaster—Improvements in machinery or apparatus for cutting or producing the pile of plain or figured velvets or other pile cut goods or fabrics.
2308. V. Renault, Bordeaux, France—Improvements in regulating and directing the steam escaping from the cylinders of locomotive engines
2309. D. Desmond, Upper Thames-street—Improvements in vessels and apparatus for storing, improving, and discharging liquids
2310. H. J. Distin, Cranbourne-street, Leicester-square—Improvements in the means of regulating the tone of kettle drums. (Communication)
2311. R. Edmeston, Bradford—Improvements in looms for weaving
2312. C. Goodyear, Leicester-square—Improvements in securing the openings of air-tight and other bags and packages
2313. M. T. Crofton, Leeds—An apparatus for indicating and registering the number of persons entering a public vehicle or carriage

Dated October 3.

2314. J. Hopkins. Lower Oxford-street, Whitechapel—Improvements in the construction of furnaces
2315. P. A. le Comte de Fontainemoreau, South-street, Finsbury—Improvements in the construction of roofs of buildings, which improvements are applicable to the construction of arches of bridges. (Communication)
2317. W. Johnson, Lincoln's-inn-fields—Improvements in the treatment, preparation, or manufacture of sheet caoutchouc, and in the combination thereof with cloth and other fabrics. (Communication)
2318. L. W. Wright, Sydenham, Kent—Improvements in gas-meters
2319. G. F. Wilson and A. I. Austen, Belmont, Vauxhall—Improvements in the manufacture of soap
2320. D. O. Boyd, Welbeck-street—Improvements in constructing and arranging smoke and air-flues
2322. R. A. Brooman, Fleet-street—An improved lathe or tool suitable for turning, drilling, boring, planing, and smoothening, also for grooving, morticing, and slotting, parts of which tool may be applied to lathes generally. (Communication from M. Fleury)
2323. J. Allen, Castle-place, Castle-street, Canterbury—Improvements in coats
2324. R. Haslam and J. Haslam, Preston—Improvements in looms for weaving
2325. C. Farquharson and W. Grimshaw, Mitcham, Surrey—Improvements in apparatus for indicating and regulating the pressure of steam in boilers.
2326. C. D. Gardissal, Bedford-street, Strand—Improvements in the manufacture of cement. (Communication)

Dated October 4.

2327. A. Picard, Rue de l'Echiquier, Paris—An improved tobacco-pipe
2328. A. V. Newton, Chancery-lane—Improvements in supplying steam-boilers with water
2329. W. Preston, Over Darwen, Lancaster—Improved machinery to be used in the manufacture of paper hangings
2330. M. Farina, Hanway-street, Oxford-street—An improved tooth-powder. (Communication)
2331. J. Betteley, Liverpool—Improvements in the manufacture of iron for knees of ships or other purposes

Dated October 6.

2332. J. Silvester, Woolwich—Improvements in the application of steam or air in the production of motive power
2334. H. Mackworth, Clifton, Gloucester—Improvements in the separation and treatment of mineral substances, and in coking, and in apparatus connected therewith.
2336. V. Avril, Paris—Improvements in the manufacture of iron and steel

Dated October 7.

2338. R. Hazard, Thanet-place, Strand—An improved apparatus for intercepting the smoke and heated gases in its passage from boilers, stoves, furnaces, and kilns, to the chimney, and thereby extracting a portion of its heat, which is made available for warming and drying purposes.
2340. O. W. Barratt, Birmingham—Improvements in the dyeing or staining and ornamenting of articles of pearl, bone, and vegetable ivory
2342. S. Bottomley, Bradford, and J. W. Crossley, Brighouse—Improvements in the manufacture of pile or nap fabrics
2344. W. Wilkinson, Nottingham—Improvements in casters in the legs of tables, chairs, pianofortes, and other articles of furniture, and in apparatus for perforating caster wheels, which is also applicable to the perforating of glass articles generally
2346. J. Bunnett, Deptford—Improvements in the manufacture of metal sashbars, columns, and mouldings, for building and decorative purposes, and for a method of protecting the same or other articles from oxydation
2348. G. F. Wilson, Belmont, Vauxhall—An improvement in the manufacture of rosin oil

Dated October 8.

2350. W. Ward, Warrington, Chester—An improved manufacture of woven fabric
2352. F. Whitehead, Crayford, Kent — A method of and apparatus for producing devices in or on wood, leather, and other similar substances, whether for ornamenting the same or for the production of printing and embossing surfaces therefrom
2354 W. Bradford, Manchester—Improvements in the arrangement of gas-burners for lighting and ventilating
2356. D. Foxwell, Manchester—An improved mode or method of consuming smoke, and economising fuel thereby
2360. H. Watson and J. Dixon, High-bridge Works, Newcastle-on-Tyne—Improvements in cocks and valves
2362. F. Jullien, Trafalgar-square, Charing-cross — Improvements in ordnance or cannon

Dated October 9.

2364. T. King, Spitalfields—An improved continuous compressing machine
2366. G. H. Cottam, and H. R. Cottam, Old St. Pancras-road—An improvement in the manufacture of iron hurdles
2368. W. Nairne, Aberdalgie, Perth—Improvements in the machinery for preparing flax, tow, and other fibrous substances
2372. J. S. Hendy, Essex-street, Strand—Improvements in fire-stoves, or grates used for domestic purposes

Dated October 10.

2376. W. Johnson, Lincoln's-inn-fields — Improvements in railway breaks. (Communication from J. J. Chatelain, Nancy)
2378. F. A. Gatty, Accrington, Lancaster—Improvements in dyeing
2380. W. Rennie, jun., Lagan Foundry, Belfast—Improvements in the condensing apparatus of steam-engines

Dated October 11.

2384. W. C. Watson, New York, U.S.—Improvements is sewing machines
2386. G. Heppell, Uttoxeter, Stafford—Improvements in ventilating mines and other like places
2388. A. V. Newton, Chancery-lane—A new gaseous liquid to be used in generating motive power. (Communication)
2390. G. Scheurmann, Newgate-street—Improvements in printing music when type is employed

Dated October 13.

2392. G. Elliot, Newcastle-upon-Tyne—Improvements in the production of oxides of manganese
2394. W. and J. Todd, Heywood, Lancaster—Improvements in power looms for weaving
2396. C. E. Möny, Paris—An improved mode of transmitting motive power
2398. J. Roscow, Radcliff, Lancaster—Improvements in machinery or apparatus for cutting or rasping dye woods

Dated October 14.

2400. R. Sumner, Droylesden, Lancaster — Improvements in power looms for weaving
2402. S. Bremner, Newcastle-upon-Tyne—Improvements in pouches or envelopes, and in machinery or apparatus for manufacturing or producing the same
2404. T. S. Cressey, High-street, Homerton—Improvements in machinery for cutting, hollowing, and backing staves

Dated October 15.

2410. B. J. Heywood, Hawley-road, Camden-town — Improvements in valves for inflating air-tight bags, cushions, and other similar articles, and for drawing off liquids
2412. J. Palmer, Stockton-on-Tees, Durham—Improved machinery for separating different kinds or qualities of seed and grain from each other

PATENTS APPLIED FOR WITH COMPLETE SPECIFICATION.

2281. H. Jenkins, Birmingham—Improvements in the manufacture of buckles and other dress-fasteners.—September 29
2382. T. Gilbert, Massachusetts, U. S.—Improved piano-forte action or string-sounding mechanism. (Communication from D. H. Shirley, United States.)—October 10
2407. J. H. G. Wells, Essex-street, Strand—Improvements in windlasses—(Communication from P. C. Hardoy, St. Esprit, Landes, France)—October 15

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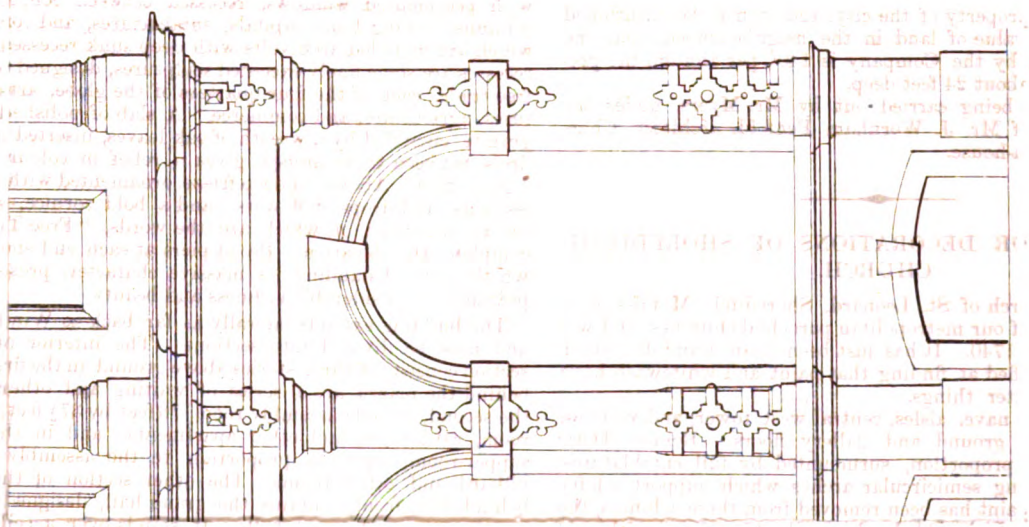

ANE.

HAM PENFOLD, ARCHT.
2 Charlotte Row.

T.P.Jobbins

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CHANCERY LANE IMPROVEMENTS — OFFICES OF THE LAW UNION INSURANCE COMPANY.

(With an Engraving, Plate XXXVII.)

We give this month an elevation of the building now in course of erection in Chancery-lane, within one door of Fleet-street, to be used for the purposes of the above Company, who are about to remove from Pall-Mall into what we may call their own peculiar quarter. The front, which is more extensive than most public offices are fortunate enough to possess, will be entirely in stone, and Elizabethan in character. The ground-floor will be occupied as a public office and secretary's room, and the first-floor will be devoted to the Board-room, and the whole of the building used entirely for the business of the Company.

The site is the property of the city, and it may be mentioned as a proof of the value of land in the neighbourhood, that the ground-rent paid by the Company is 140*l.* per annum, the premises being only about 24 feet deep.

The works are being carried out by Mr. Myers, under the superintendence of Mr. J. Wornham Penfold, architect, Charlotte-row, Mansion-house.

THE INTERIOR DECORATIONS OF SHOREDITCH CHURCH.

The parish church of St. Leonard, Shoreditch, Middlesex, is one of the finest of our metropolitan parochial churches, and was built by Dance in 1740. It has just been cleaned and decorated, and we are gratified at finding that paint and whitewash have given place to better things.

The church has nave, aisles, central west tower, and vestries, on a level with ground and gallery floors. Roman Doric columns of good proportion, surmounted by full entablatures, from whence spring semicircular arches which support a lofty clerestory. The paint has been removed from these columns, the architrave and frieze marbled; the triglyphs relieved with gold and colour; the cornice decorated with a pattern; soffits of arches ornamented with Greek scrolls and patera, and the archivolts marbled; the spandrels and the cornice which runs under the clerestory windows are decorated with patterns chiefly in green and gold. The columns supporting the western gallery, and the dressings to the vestry doors are marbled, as sienna. The remaining wall spaces are tinted in plain colours, the panels to nave ceiling relieved with distemper tints, and the ceiling flowers gilt.

But the chief attraction is the chancel; the ceiling has a glory and clouds; the space between ceiling and cornice of entablature is tinted in plain colour, and partly relieved with festoons and cherubs; the cornice bears a pattern similar to that of the clerestory, but the frieze has a rich design of interlaced gold, arranged to form panels, in which the Dove and Paschal Lamb are introduced on an azure ground; the pilasters are marbled in sienna, and the entire wall spaces under entablature covered with wall patterns and diapers. Panels are designed with rich borders to receive the "Belief" and "Commandments:" much care seems to have been bestowed upon what artists term the black and white of the picture, and although a great deal of colour has been used, yet the effect is satisfactory,—a result due entirely to the use of neutral colours.

The decoration has been executed most judiciously and with considerable taste by Mr. Knightley, the architect, of 25, Cannon-street, who entrusted the performance of the work to Mr. Kuckuck, of Pall-mall.

We regret the existence of the high pews; these should have been removed.

A handsome church is now being erected at Umballah, East Indies, under the superintendence of Captain G. F. Atkinson, Bengal Engineers. The tower and spire will be 200 feet high, the nave, 117 feet by 30 feet long; the chancel, 50 feet by 26; the walls, 45 feet high to roof; to top of roof, 65 feet. It will be one of the finest churches in India. The stained glass for the east window and tower is being prepared by Mr. N. W. Lavers, of London.

THE NEW FREE TRADE HALL, MANCHESTER.

The new Free Trade Hall, Manchester, recently opened, is an exceedingly handsome stone building, in the Lombardo-Venetian style of architecture, the building contract for which was 25,000*l.* and the total cost, including decorations and furnishing, will probably be about 32,000*l.* The principal front is about 160 feet long and 75 feet high, in two stories. The front of the ground story is a piazza of nine arches, resting on massive piers.

The spandrels of these arches are sculptured, displaying on shields, encircled by branches of laurel and oak, the arms of Manchester, Salford, and the boroughs of Liverpool, Rochdale, Bury, Oldham, Bolton, Stockport, Ashton, and Wigan. From a projecting cornice over these rises the upper part of the building, with pedimented windows, recessed between coupled engaged columns, having Ionic capitals, entablatures, and cornices, over which are moulded archivolts with deep sunk recesses. In these recesses are some finely executed sculptures, designed to represent free trade, each of the four quarters of the globe, arts, manufactures, agriculture, and commerce. A slab of polished Aberdeen granite, encircled by a wreath of oak leaves, inserted in the spandrels between these arches, gives a relief in colour which has a good effect. Above is a deep frieze, ornamented with medallions, festoons, and drops of flowers; and a bold cornice, surmounted by a balustrade, on which are the words, "Free Trade Hall," completes the elevation. Broad piers at each end enclose a front which, notwithstanding its massive character, presents an appearance of considerable richness and beauty.

The building extends laterally as far back as Windmill-street, and may be divided into sections. The interior of the front section consists of three stories above ground, in the first of which, behind the piazza, are a series of waiting and other rooms; in the second, a noble assembly-room, 76 feet by 37½ feet, a drawing-room, card-room, and other apartments; and in the third, a supper-room, equal in proportion to the assembly-room, and billiard and other rooms. The other section of the building, behind this front, contains the grand hall, designed for public meetings, concerts, and balls. It stands over a cellar or basement story, the floor being about 10 feet above the level of the street. It is about 134 feet long, 78 feet wide, and 52 feet high. This is about 4 feet longer and 6 feet wider than Exeter Hall. It is the same length as the old Free Trade Hall, but 27 feet narrower. It has a platform at one end, while the other end of the room is semicircular. A gallery extends round the sides and semicircular ends of the hall, and above this are also five balconies at the semicircular end. The ceiling is flat, having a very deep cove round it, and contains five circular lights, each of 13 feet diameter, so that the room will be adapted for day as well as evening meetings. It will seat comfortably 4000 people, and will accommodate more than 7000 standing. The gallery is comparatively low (so that the audience seated in it and in the body of the hall will seem almost identical), and forms an ornamental stringcourse in the deep plinth, or surbase.

The colouring and decoration have been designed with much taste by Mr. George Jackson, in whom the architect of the building, Mr. Walters, has had an able coadjutor. Looking at the interior of this hall, one of the most striking features that attracts the eye is the absence of pillars, and every obstruction to sight and hearing. The ceiling, notwithstanding its great span of 78 feet in width, and greater length, is upheld without any support from within, and has an exceedingly light and graceful appearance, though really composed of very heavy material in iron and plate-glass. The gaslights for evening meetings are by Mr. Bradford, of Manchester, on a plan similar to those of the House of Lords, but with improvements, securing good ventilation. The staircases and corridors, giving ingress and egress to the hall and various parts of the building, are wide and commodious, and these are so well contrived that it is calculated that three great meetings might be held in various parts of this new Free Trade-hall at one time without fear of confusion, each meeting-room having its own separate committee and retiring rooms for private business. The general contracter for the building was Mr. George Harrop, of Manchester, and Mr. Thomas, of London, has executed the allegorical sculptures described in the principal front.

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REVIEWS

The Elements of Practical Hydraulics for the Use of Students in Engineering. By SAMUEL DOWNING, M.A., Professor of Civil Engineering in the University of Dublin. London: Longman. 1855. 8vo. pp. 124.

This work is intended as a text book for students in the school of engineering of Trinity College, Dublin, and contains an exposition of the views of the best-known investigators of the principles which regulate the efflux of fluids. It does not appear that the author has presented any original researches of his own, but the compilation which he has undertaken is in general carefully made, and has the merits of being arranged on an intelligible system, and of exhibiting comparisons of theoretical conclusions with the observed results of numerous experimenters.

The three divisions in which this treatise is arranged are established by the following consideration. The water issuing from a vessel may be, *first*, maintained at a constant surface—or, *secondly*, may be gradually exhausted: moreover, the discharge may take place from an orifice freely, or, *thirdly*, so that the efflux is restrained by the pressure of a channel. Hence, Chapter I. treats of the discharge of water from an orifice of a reservoir, the surface being at a constant level; Chapter II. of discharge of water under a variable head, and Chapter III. of the flow of water through pipes, artificial channels, and rivers.

The whole of the investigations of the efflux from an orifice is based on a fundamental theorem known as the "Theorem of Torricelli," which determines the velocity of the issuing fluid to be that due to *a body falling freely in vacuum through a vertical space equal to the depth of the orifice of the fluid below the surface.* A proposition on which the main part of the treatise is based ought to have been carefully proved, the assumptions on which it is founded very distinctly pointed out, and the practical cases to which those assumptions do not apply, explained. Mr. Downing appears to us not to have done this, nor to have fully apprehended the difficulties connected with the proposition: the reasoning also on which he attempts to establish it seems to us radically wrong. Before, however, considering his method, it may be as well to say something of the nature of the proofs which are best known among philosophers.

The law of efflux just mentioned was ascertained experimentally by Torricelli, and by him announced as the result of observation at the end of a short treatise *De motu gravium naturaliter accelerato*, printed in 1643. Imperfect theoretical explanations of this law were given by Newton in the second edition of the *Principia* (1714), and by Varignon (Mem. Acad. Paris, 1703). The first satisfactory demonstration of Torricelli's law was given by Daniel Bernouilli in the "St. Petersburg Memoirs," 1726; and was founded on the Principle of Conservation of Vis Viva. There are other demonstrations, deficient in rigour, by Maclaurin and John Bernouilli; but the fulfilment of the object which they proposed, of deducing the principle from the fundamental laws of motion, was reserved to D'Alembert, who, assuming after Daniel Bernouilli the hypothesis of parallel sections, deduced the theorem from the principle of Dynamics known as D'Alembert's, at the end of his *Traité de Dynamique* published in the year 1743, and the year following, with numerous details, in his *Traité des Fluides*. For the particulars of this paragraph we are indebted to the excellent Collection of Hydrostatical Problems by Mr. Walton, who refers for further information in this subject to a memoir by Borda, published by the Paris Academy in 1766.

Poisson, in his *Traité de Mécanique* § 667, has investigated the motion of fluids on the particular hypothesis known as that of *parallel sections*, which supposes that when the fluid issues from a vessel, the horizontal indefinitely thin strata of fluid move parallel to themselves. This is equivalent to neglecting the differences of vertical velocities of points in the same stratum, and to assuming each stratum to be composed of the same molecules throughout the movement. The horizontal velocities are also supposed to be inconsiderable compared with the vertical. These suppositions are more nearly conformable to experiment, as the horizontal dimensions of the fluid vary less and their differences are smaller compared with the depth of the fluid. In these cases the particles are observed to move nearly in the manner supposed, except in the neighbourhood of the orifice. There, if the area of the orifice differ considerably from that of the contiguous part of the vessel, the particles move obliquely, and the hypothesis of parallel sections is no longer admissible.

Assuming, however, the hypothesis in question, Poisson investigates the motion of any horizontal stratum according to D'Alembert's principle, the product of the mass and its acceleration being equated with the effect of gravity and the difference of pressure in its upper and lower surface. He then constructs the "equation of continuity" furnished by the consideration of the incompressibility of the fluid, and finally shows that where the upper surface of the fluid is considered either descending or maintained always at the same altitude, the velocity of issue after a time becomes approximately equal to that required by Torricelli's theorem.

We may see the same result more briefly, as follows: The Principle of Conservation of Vis Viva, as applied to the present case, shows that if there be no loss of *vis viva*, the sum of the *vires vivæ* gained by the particles during any time is equal to twice the total mass multiplied by the descent during that time of its centre of gravity. To estimate the latter, let the mass of a thin stratum at the surface of the fluid be μ, and the mass of the rest M. If the fluid surface be supposed to be of invariable form, and to descend a distance equal to the thickness of the stratum μ, a like quantity of fluid will have descended below the orifice. The descent of the centre of gravity may, therefore, be exactly represented by supposing μ removed from the surface and placed below the orifice. Therefore, if h be the depth of the fluid, its centre of gravity has descended a distance $\frac{\mu h}{M + \mu}$. Hence, by the Conservation of Vis Viva, we have, supposing $\Sigma (m v^2)$ to be the *vis viva* gained during this descent,

$$\Sigma (m v^2) = 2\mu g h \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

Now, if the horizontal dimensions of the vessel be supposed to be everywhere large compared with the area of the orifice, the velocities will be everywhere small except near the orifice. Also, if the efflux continue for a sufficient time, the motion will become *steady* so that the velocity of efflux will vary but little, and the particles will descend with little alteration of velocity till they nearly approach the orifice. *If, then, we neglect their accelerations near the orifice*, the *vis viva* gained as represented by (1) is inconsiderable for all the particles above the orifice; and if u be the velocity of efflux, μu^2 is the *vis viva* gained during the supposed descent. Hence,

$$\mu u^2 = 2\mu g h; \text{ or } u^2 = 2gh \quad \ldots\ldots\ldots\ldots\ldots \quad (2)$$

the required result.

It will be observed that the hypothesis of parallel sections is not required for this demonstration. The assumptions here made as to the steadiness of the motion, and the smallness of the accelerations above the orifice are, in fact, equivalent to those by which Poisson deduces the simple formula just given, from another more general, by neglecting terms of the latter, which become small when the area of the orifice is small and the duration of motion considerable. The method adopted in Professor Miller's 'Treatise on Hydrostatics,' paragraph 71, requires similar assumptions. But the method here adopted is, in some particulars, more instructive than that founded on D'Alembert's principle, for it shows that for the purpose of obtaining Torricelli's formula it is not necessary to suppose the movements above the orifice horizontal. Hence the formula acquires a greater degree of generality than D'Alembert's method appears to give it. For instance, it would apply where the fluid rotates uniformly; and where the upper surface is not horizontal, provided that it be constant in form.

It is to be carefully observed, however, that, in fact, this result is only approximative; for it is obvious that whatever the form of the vessel, the velocities near the orifice must be nearly equal to that below the orifice. Hence a more accurate result would be obtained by considering the *vis viva* due to the former velocities. We might conceive, for instance, a hemisphere to be described above the orifice of such a magnitude that if all the particles in it had the same velocity as that of efflux, their *vis viva* would be equal to that of the real *vis viva* gained by the whole fluid above the orifice. Call the mass within this imaginary hemisphere μ^1. Then from equation (1),

$$(\mu + \mu^1) u^2 = 2\mu g h;$$

a result which would be strictly correct if the fluid suffered no loss of *vis viva* from friction and impact of the particles. To give this result significance, we should have to find the ratio of μ to μ^1, and this might be done approximately by supposing the veloci-

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ties in the neighbourhood of the orifice to vary according to some arbitrary law, so that they decreased rapidly as the distance from the orifice increased.

Mr. Downing neglects all these considerations; and, as it seems to us, all the substantial difficulties of the subject. His demonstration of Torricelli's theorem is as follows:

"By the first principles of Dynamics, in order that a body impelled in a vertical direction should reach to any height, it is necessary that at the point of departure it should have had a velocity equal to that which it would have acquired in falling freely from that height; consequently the particles of the fluid must have had a velocity nearly equal to that due to the charge—that is, to the height of the surface of the water above the orifices." § 8.

This mode of reasoning, however, merely assumes what has to be proved, that the particles at the orifice move as if they descended freely by the action of gravity, and takes no account of the effect of the internal pressures of the different parts of the fluid. This reasoning moreover proves far too much; for in the first place it would seem to prove the theorem, not merely for the case to which, as we have seen, it is confined—that of small orifices—but for the case of large orifices also; and again it would apply with respect to the velocities at all points of the fluid, and not at the orifice merely; whereas, in the interior of the fluid, velocities are in general far less than those due to free descent under the action of gravity; being, in fact, less than those at the orifice, in a ratio depending on its horizontal dimensions and those of the vessel.

The confusion of the author's views respecting the fundamental theorem on which his treatise is mainly based, further appears from the reasoning by which he attempts to show that Torricelli's theorem "extends to every kind of fluids—to mercury, oils, alcohol, and even aeriform fluids." (§ 10.) In the first place, Torricelli's theorem is *not*, as here supposed, applicable to aeriform fluids; for, as we have seen, the demonstration of that theorem involves the consideration of the incompressibility of the fluid. If Torricelli's theorem were applicable to elastic fluids, the formula for their velocity ought to involve the altitude of the vessel containing them, whereas Poisson has shown (*Mécanique* § 678) that the velocity of effux of an elastic fluid depends only on the height of the barometer, the atmospheric pressure, and the elastic pressure of a particular part of the fluid—that is, is independent of the dimensions of the vessel.

In the second place, Mr. Downing's reasoning in support of the extended application of Torricelli's formula is inconsistent with his previous demonstration of that formula. He says:

"Take the case of mercury: the particles situated immediately in front of the orifice, and in which it is necessary to create a certain velocity, are, it is true, fourteen times more dense than those of water, and they consequently oppose to motion a resistance fourteen times greater than it would do; but the mass also which presses on these particles, and produces the velocity of exit, being greater in the same proportion, gives a motive force fourteen times greater. Thus a compensation exists, and the velocity impressed remains the same; and in like manner it may be proved for a fluid lighter than water." § 10.

It will be observed that here our author states that the cause of the "velocity of exit" of the issuing particles is "the mass which presses on those particles;" whereas, in the passage previously quoted (§ 8), he considers the motive force acting on them to be their own gravity only, and neglects the pressure of the contiguous fluid. The fact is, that the gravity neither of the issuing particles nor of the contiguous fluid alone, but of both together, produces the motion.

An important part of the science of hydraulics is the effects of the phenomenon known as that of the *vena contracta*, or "contraction of the fluid vein." The particles of fluid necessarily approach the orifice more or less obliquely; and, consequently, converge to a point beyond the orifice. The result is a contraction of the fluid vein externally, which continues up to a certain point where the transverse section is a *minimum*. The flow of water is generally considered to be the same as if the orifice had this section, which is found by experiment to bear a ratio to the area of the orifice = 0·62, independently of the height of the charge. If to the orifice be fitted a small cylindrical tube or adjutage, the particles will issue with movements more nearly parallel than when the orifice is made in a thin plate, and the discharge will be increased. It appears from some experiments cited, § 35, that this increase of discharge is due to the parallelism of the movements of the issuing particles: for it is shown by direct experiment that the velocity is about 0·82 of that given by Torricelli's formula, and the discharge is also found to be about 0·82 of that theoretically computed.

To each chapter is appended a collection of examples and practical applications of the theorems. Among these we notice for its interest the calculation of the effects of the apparatus adopted in Piedmont, and other parts of Italy, to determine amounts of water supplied for irrigation. In the irrigated districts it is a matter of great importance to determine the volume of water supplied to each landholder from the public canals of irrigation. The Sardinian civil code defines the unit of measurement of all grants of water by the quantity of water passing through a rectangular opening of given area under the pressure of a defined constant head of water. In order to maintain this constant head of water in discharging the water for irrigation, the following ingenious contrivance is adopted: The water, instead of passing directly from the canal to the private channel, first passes by a sluice into a measuring chamber, of which the bottom is level, and thence by an aperture in it to the land to be irrigated. The water is kept at a constant level in the measuring chamber by raising or lowering the sluice.

Our author describes some other contrivances for the same purpose, among them the *modulo magistrale*, invented by Soldati, of Milan, about the year 1571, in answer to an invitation from the magistracy of that city to architects and engineers to design a measuring apparatus. We conclude the present notice with the following remarks of our author on this invention, as they exhibit a favourable instance of his style, and also show something of the difficulties and discrepancies which at present appear inseparable from hydraulic computations.

"The differences in the estimates of the quantity of water discharged by the *modulo magistrale*, as given by different Italian engineers, are very remarkable, considering the great attention that has been paid to the theory and practice of hydraulics in that country. De Regi gives it as 1·42 cubic feet per second; Breschetti states the average result of experiments on the Muzza Canal to give 1·57 cubic feet per second; Mazzeri estimates it as low as 1·21 cubic feet; Brunacci at 1·46; while the Department of Public Works in Lombardy considers it equal to 1·64 cubic feet per second. The extremes, we see, are 1·21 and 1·64 cubic feet per second,—a difference of ·43 cubic feet, between a third and fourth of the total discharge. Captain Smith accounts for this great difference by stating, 'That the estimate of the government is founded on the experience of the results on the great canals, where the outlets are almost uniformly of large dimensions' (pp. 222, 223, vol. i.). Now it is certain that, all other circumstances being alike, the quantities of water discharged from large are proportionally greater than those discharged from small outlets. Hence the *oncia magistrale*, as determined by experiments with the former, has a decidedly higher value than when determined by the latter. The cause of this is clear. To give a discharge of, say, six water-inches, the breadth of the outlet is made six times that for one inch, the height and the pressure remaining in both cases the same. The proportion between the sectional area and perimeter of the outlets becomes, however, materially altered, and the influence of the perimeter in effecting the contraction of the vein diminishes gradually as the size of the outlet increases: and in a similar proportion the discharge becomes greater. To elucidate this, it may be remarked, that in an outlet for one *oncia magistrale* the ratio of the section to the perimeter is as 1 to 23·33; for two, as 1 to 16·66; for four, as 1 to 13·33; for eight, as 1 to 11·66; for ten, as 1 to 11·33, or about half what it is for one *oncia*; for twenty *oncia*, as one to 10·66, and so on; and there are real differences of discharge due to the variable ratios now given. Very serious pecuniary loss may consequently be the result to the proprietors of the canal or the consumers of the water. It appears (vol. i. pp. 226, 227) that for summer irrigation each cubic foot per second is capable of irrigating 61·8 acres, and that the annual rent of this quantity, summer and winter, is 13*l.* 5*s.*; the difference of ·43 cubic feet between the highest and lowest estimate of the discharge of the *modulo magistrale* is worth 5*l.* 13*s.*, and would irrigate 26 acres at the above rate. The recognition of the differences between the discharges of large and small outlets was very early made in Lombardy. In the *module* of Cremona, invented in 1561, no single outlet was allowed to exceed 1·31 high by 3·18 broad, equal to about 12 or 13 water-inches. In the Milanese single outlets have been restricted for nearly three centuries and a-half to discharges of from 9 to 12 *once*. In Piedmont they have been more careful, and have three limited single outlets to 6 *once*, which, by general consent, seems to be the most approved size for diminishing to the utmost the error due to the inequality of discharges from large and small openings. For practical purposes, therefore, and taking the mean of the various estimates of the value of the *oncia magistrale* just adverted to, it may be considered as equal to very nearly 1¼ cubic feet per second.

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The Modern Practice of Boiler Engineering, containing observations on the construction of Steam Boilers, and upon Furnaces used for Smoke Prevention. By ROBERT ARMSTRONG, C.E. Revised, with additions, by JOHN BOURNE. London: E. and F. N. Spon. 1856. 8vo. pp. 194.

The collected experience of a practical engineer, who for thirty years of his life has directed his attention to the construction of steam-boilers and furnaces, is a valuable addition to the stock of engineering knowledge; and it will be generally more appreciated because it is condensed within so small a volume as the one before us. The points principally noticed are the advantages of using high-pressure steam with corresponding strong boilers, the prevention of smoke and boiler explosions; on each of which subjects Mr. Armstrong expresses himself strongly, as a man fully convinced by experience of the correctness of his opinions.

The forms of boiler generally adopted are first considered, and the merits and demerits of each stated. The marine boilers as at present constructed are those that specially call forth Mr. Armstrong's reprobation, the multitubular boiler being called "a disgrace to the science of this age of progress." He proposes two methods of improving the existing construction. If a moderate improvement only be permitted, he says the obvious course is "to improve the furnace, shorten and widen the tubes, and, when the draft is deficient, apply the exhausting-fan with a short funnel." When a radical reform of the marine boiler is determined on, then the following changes must be adopted:

"The boilers, in the first place, ought not to be 'crushed down' to the bottom of the ship, where the draft has such difficulty to descend down after them. We would, in fact abolish the stoke-*hole*, if not do away with the stokers, and *stoking* also. Instead of placing the fires so low down that, in a leaky ship they are soon drowned out, we would have them close up to the deck, in whatever situation the engines might be fixed. The 'firing stage' should really be a platform elevated to the light of day, on which the most important processes in the economy and progress of a steam-vessel is carried on, and to which the coals may be elevated, and, if required, placed in the furnaces also, by means of very simple self-acting mechanical appliances. In giving a reluctant assent to the proposition, let it not be forgotten by the reader, that this change of position in the boilers would really *increase* the available room for cargo, inasmuch as none would be wasted in passages up and down for the hands, and for ventilation, to say nothing of the greater safety of the ship from *fire;* and though last, not least, when we think of the possible fate of the 'President' or the 'Pacific," from *explosion*.

In the case of vessels of war where the boilers, in this elevated position, might be obnoxious to the effects of shot, &c., the boilers may be retained in the usual position, and in such cases the room occupied by the stoking space is not so objectionable. Wrought-iron boilers of simple forms, containing a steam pressure of 200 lb. per square inch, will be the most suitable in such cases."

Mr. Armstrong takes for granted that there is great economy in the use of high-pressure steam, and for sea-going vessels he says he does not see how high-pressure is to be avoided; such pressure being carried in war ships to the utmost attainable degree. Taking that view of the economy, and even the necessity, of working with high-pressure steam, he is of opinion that it would be true economy to adopt the very strongest boilers that can possibly be made at once. The boiler that he most approves is the Galloway conical-tube boiler, in which the space behind the furnace is occupied by tubes of 5 or 6 inches in diameter at their lower ends, and nearly double that diameter at their upper ends. The dimensions of boilers of this construction are given that work safely with pressures varying from 35 to 50 lb. on the square inch, but Mr. Armstrong omits to give the dimensions and thickness of plates that would be required for the pressure of 200 lb., which he considers it so desirable and almost essential to attain. There is one point whereon he lays much stress, which deserves the serious attention of engineers. He contends that it is a dangerous practice to test boilers over-much; many boilers that stand for a short time a test three times greater than the intended working pressure being so seriously damaged by the strain, that when afterwards subjected to the working pressure for a continuance, give way at the weakened point.

Mr. Armstrong speaks in no measured terms of the smoke doctors, whom he holds in supreme contempt. Mr. Charles Wye Williams is more especially the object of attack, as he has been placed conspicuously at the head of those who undertake to clear the atmosphere from smoke. Mr. Williams has not been sparing of censure on those who profess to *burn smoke*, and his own plans for the prevention of the smoke nuisance, recently rewarded with a gold medal by the Society of Arts, now come in for a still larger share of abuse from Mr. Armstrong and his annotator. The introduction of jets of cold air at the bridge of the furnace for the inflammation of the gases at that point, it is contended, burn the boiler-plates, diminish the draught, and thereby damp the fire and obstruct the generation of steam. To clench these objections by facts, the "Copy of a report on Williams's patent smoke-burning furnace" is inserted, which points out specific injuries sustained by a boiler heated by one of those furnaces. Mr. Armstrong maintains that the prevention of smoke is generally accompanied by waste of fuel instead of economy, as the carbon is converted into carbonic oxide, which escapes, invisibly indeed, and carries off at the same time a large portion of inflammable gas. In the furnace constructed by Mr. Armstrong for the prevention of smoke, the air is principally admitted in the middle of the fire, between the fire-door and the bridge, in what is called the "universal argand fire-grate." By this method of supplying air, the *disappearance* of the smoke is not so perfect, but it is asserted that the economical effect is much greater. The following is given as a theory of the best possible combustion in steam-engine furnaces:

"It is true that smoke is the result of imperfect combustion, but it is also true that combustion may be still more imperfect without smoke, and be attended with with a much greater waste of fuel. In a steam-engine furnace, there never was, and never can be 'perfect combustion,' even in theory much less in practice. In the nearest apparent approach thereto, when no visible smoke escapes from the chimney, there always arises from a fire of tolerable thickness a certain quantity of unconsumed inflammable gas, chiefly carbonic oxide, whilst at the same time, a very large proportion (according to experiments by Peter Ewart and John Dalton about one half) of the gaseous products passing off by the chimney consist of atmospheric air unchanged, that is, containing its full proportion, about one-fifth of oxygen. Now since it is impossible to increase the supply of oxygen, which by combining with the fuel in the furnace is alone the cause of all the heat produced, without at the same time increasing the supply of the other component of the atmosphere, consisting of four-fifths of it, namely, the nitrogen; and allowing, as above, one half only of the oxygen to be available, it follows that about nine-tenths of the atmospheric air admitted into the furnace, and heated to a temperature of about seven hundred degrees, is carried off by the chimney for no purpose whatever, except to enable the remaining one-tenth to support the combustion of the fuel.

"An exception may be taken to this on the ground that some part of this waste heat may be recovered by an extended heating surface of the boiler; that, however, is limited in practice by other circumstances, and does not affect the above conclusion as regards the furnace considered by itself.

"Whether heat is a material substance or not, which is immaterial to this question, it is quite certain that in its production from the burning of common bituminous coal, the main elements concerned are carbon, hydrogen, and oxygen, and that the complete conversion of these three substances into carbonic acid and water without waste, is the only common-sense idea that can be conceived of complete or 'perfect combustion.' And, if we could have a continued supply of oxygen without its accompanying nitrogen, such complete combustion might be possible, but as we can only have these two elements mixed as we find them in the atmosphere, and one of them having to be separated from the other, as they pass through the furnace, whilst so large a portion as nine-tenths of the whole is of no use in the process, the case is considerably altered.

"Take, for instance, any given ordinary furnace, and supposing it to be in operation and supplied with fuel at a given uniform rate, if we then suppose the air supporting the combustion to be supplied at a uniformly increasing rate, it is certain that a maximum point, in the relative proportions of the air and fuel, must be somewhere arrived at, where the expenditure of heat on the liberated nitrogen and other incombustible products escaping by the chimney must counterbalance the heat created by the consumption of that portion of any combustible gas or smoke that would otherwise pass off unconsumed in the same way—the former increasing as the latter diminishes, and *vice versa*.

"This maximum point of best possible combustion once attained, we can neither pass nor fall short of it without diminishing the temperature and eventually stopping the process; or, in other words, the oxygen which alone supports the combustion, must not only create as much heat as is sufficient for heating itself, but also as much heat as is required to heat up to the same degree all the air or gases with which it is in contact, otherwise the combustion will not go on at the same rate, and consequently a lessened supply of steam to the engine results, and less power, the only true measure of heat, is produced.

"The natural conclusion from the above theory—which is also in strict accordance with all successful experience—is, that the most economical method of firing a steam engine boiler, from which a constant quantity of steam is required, must be by a regularly uniform supply of fuel to the furnace, and a similarly regular supply of air through the fire-grate 'and no where else,' with a uniform though moderate emis-

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sion of smoke, visible or invisible, from the chimney; *visible* within certain limits of density of shade as the combustion is more or less imperfect, being least imperfect when the combustion is quicker and the resulting products contain the largest proportion of carbonic acid gas and steam, holding in suspension a thin grey colouring of carbon or soot, which constitutes ordinary smoke; *invisible* when the combustion is slower or more imperfect, allowing the carbonic acid first formed to be replaced in the escaping products by a large quantity of carbon, in the form of carbonic oxide gas, thereby wasting, at least theoretically, nearly half the available carbon of the coal."

There are many other parts of the subject that deserve special mention, but the volume itself is in so small a compass that most readers who are interested in the construction of boilers will not fail to possess it.

STRENGTH OF ARTILLERY.

In the last number of this *Journal* (p. 389), we published a letter from Mr. Hart, Fellow of Trinity College, Dublin, objecting to certain investigations given in the preceding number (p. 325) in a review of Mr. Mallet's 'Treatise on the Physical Conditions involved in the Construction of Artillery;' and we now proceed, according to our promise, to reply to Mr. Hart's letter. We may premise that he argues the questions between us fairly, and that we feel none of that reluctance in engaging in controversy with him which we should feel if arguing with an opponent who substituted crude physical conceptions for an exact knowledge of mechanical science.

The question at issue may, we presume, be fairly stated as follows: Mr. Mallet proposed a method of constructing cannon of several concentric rings put one over the other at different temperatures, so that when cold they grasped each other with different degrees of tension; and he conceived that these tensions could be so regulated that, when the cannon was subjected to a given explosive pressure, the material would have the same tension throughout. In an investigation appended to Mr. Mallet's work, Mr. Hart adopts the opinion that it is possible to secure this uniformity of tension. We, on the other hand, disputed the possibility of attaining this result.

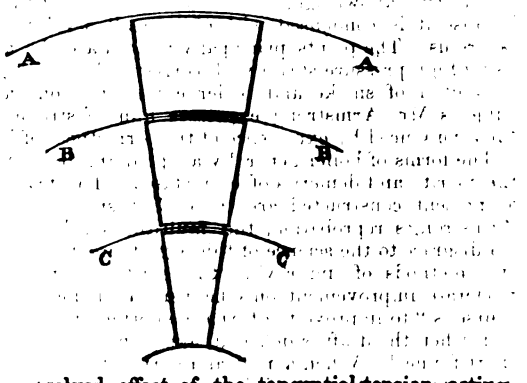
The difficulties of the subject arise from uncertainty as to the relations between the elastic forces of bodies subject to strains in different directions. When a bar or block is subject, not to lateral strains but to longitudinal only, there can be no doubt that approximately, according to Hooke's law, the tension is proportional to the extension. When, however, the body is subject to lateral forces also, the laws of elasticity are more complicated, and, as at present, matter of controversy.

If the two kinds of elasticity be considered to act independently of each other, then it can be demonstrated without the aid of mathematical symbols, that the supposed equality of tension of the concentric rings is impossible. The hypothesis of independence of the tangential and normal strains is that adopted by Mr. Hart, and may be, indeed, conceived to be secured by several mechanical devices; for instance, by supposing each ring to be a metallic network of circular and radial wires interlacing each other, or supposing each ring to be a thin circular band separated from the next ring by voussoirs which touch but do not press each other. Admitting then, that by Hooke's law, the normal tension is proportional to the normal extension, and the tangential tension to the tangential extension, let us see the consequences of that hypothesis.

Now, if the tangential tension of the rings be uniform, we must suppose that every part of each of them is equally extended tangentially. Consider, therefore, the equilibrium of any small annulus, part of one of the rings, and concentric with it. Since every part of this ring is subject to the same tangential tension, it follows that as compared with their lengths before they suffer any strain, the inner and outer circumferences of the annulus are extended in the same ratio. Consequently their radii are increased in that ratio; and therefore the difference of their radii (or the thickness of the annulus) is increased in the same ratio. And if any other annulus be taken, its thickness is increased in the same ratio.

For instance, let the inner and outer radii of the first annulus be, when the metal is unstrained, 40 and 45 inches respectively; and let the tension be such as to extend the metal by one-fifth of its length. Then the radii become 48 and 54 inches respectively, and the thickness of the annulus which was originally 5, is now 6 inches, or has been increased by one-fifth. In the same way the thickness of every other annulus is increased by one-fifth.

It follows then, that in every part the ring is subject to the same normal extension, and therefore, by Hooke's law, to the same normal tension. But this result is obviously impossible if the vessel be subject to an explosive pressure within, and to none on its exterior surface. For if we consider the equilibrium of equiangular segments of several annuli represented in the diagram, it is obvious that the outermost segment is



subject to the resolved effect of the tangential tension acting between A A and B B, and producing a pressure on the latter surface; but the pressure at C C is due to the cumulative effect of these tensions and those acting between B B and C C, and consequently the normal pressures are greater as the surfaces at which they act are nearer the centre. Hence we have a condition incompatible with that before arrived at, or the equilibrium is shown to be impossible under the supposed circumstances.

Now all that we have here demonstrated is, that it is impossible to construct a cannon of concentric rings so as to be of uniform tension under the action of explosive force, if the normal and tangential elasticities act independently. If, however, those elasticities be dependent on each other, it remains for those who oppose our views to show, that by reason of that very dependence the impossibility ceases. This must of course depend on the nature of the relation assumed to exist between the two elasticities. If it be that assumed by ourselves in accordance with the views of the most eminent mathematicians who have written on the subject, the supposed uniformity of tensions is not only demonstrated to be impossible, but is not even approximately attainable. So that if Mr. Hart could show the new law of elasticity required to secure this uniformity to be experimentally accurate, he would show that the results of previous experimenters do not even approach correctness. But that the received laws of elasticity are at least approximately correct, appears to be demonstrated by numberless investigations, including those of the laws of vibrations of sound and heat.

Not only the law of elasticity adopted by us, but also that of Mr. Hart in the investigation cited, leads to the same conclusion as to the impossibility of the supposed uniformity of tensions. In our investigation we arrived at an equation (7), from which it appears that the tension at any distance from the axis of the cannon varies as a quantity depending on the square of that distance. Mr. Hart, also, at page 263 of the work reviewed, gives a formula from which it appears that the tension depends on the square of the distance. Our formula was

$$t = \frac{a^2}{r^2}\,\frac{R^2 + r^2}{R^2 - a^2}\cdot p \qquad \ldots\ldots\ldots\ldots\ldots\ldots (7)$$

where t is the tension in question acting at any distance r from the axis, R and a the radii of the outer and inner surfaces respectively, and p the explosive pressure. Mr. Hart gives *literatim* the expression

$$F\,\frac{R^2 + x^2}{R^2 - \ldots^2}\cdot\frac{r^2}{x^2}$$

which he states "is the measure of the extending force on each square inch of the material," having previously defined F to be the internal pressure, R and r the radii of the outer and inner surfaces, and x any other radius.

It will be seen that Mr. Hart's formula and ours are actually identical. It is difficult, therefore, to understand how he can consistently with himself object to our equation (7). Our conclusion he designates a paradox, using the words "the sole proof

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of this paradox being, that your 'equation (7) is equally true whether any ring were stretched or compressed before the pressure p was applied;' " and then proceeds to question the accuracy of this equation (7). But in truth it was not necessary to give any equation of our own for the purpose of our argument, and we might have contented ourselves with adopting Mr. Hart's for that purpose. Neither can we understand how, having given that equation, which shows the tension is necessarily variable, he can consistently proceed (at p. 263 of the work reviewed) to calculate conditions, so that "when the greatest internal pressure is applied the tension $T = k\frac{\partial}{x}$ shall be uniform throughout the tube."

This he does by integrating a certain differential equation, assuming T to be constant. But surely it is a *petitio principii* to thus assume that quantity to be constant which he had before treated as variable; and having deduced a definite result from that assumption, to say that the invariableness of the tension is thereby ascertained.

The force of the objection to the equation $n + t = C$, where n is the normal, and t the tangential tension, we readily admit, so far as it shows that the equation is not perfectly accurate. But, in the first place, we never proposed the equation as otherwise than approximative, and in the second place the equation is not our own, but is founded on the experimental laws adopted by Prof. Stokes, Cauchy, and other eminent mathematicians. In this part of his strictures, therefore, Mr. Hart's dispute is with them, not with us. And here we must take leave to remark that he seems hardly aware of how much has been written on the subject of the mutual relations of elastic forces, and of the difficulties with which the subject is invested. He says at page 261 of the work quoted, that "it remains still to be proved by experiment whether the resistance to extension is diminished or increased by simultaneous compression in a transverse direction, and *vice versâ*." But in reality analogous experiments have been made, and the results of them elaborately investigated. For some account of the literature of this subject, we may refer to Mr. Maxwell's paper in the 20th volume of the 'Edinburgh Transactions,' already cited by us, and to Mr. Rankine's paper on the 'Laws of the Elasticity of Solid Bodies,' in the 25th number of the 'Cambridge and Dublin Mathematical Journal.' If Mr. Hart can contribute any more accurate laws, we can assure him his results will be most acceptable, not only to us, but to the whole body of far more able investigators of the laws of elasticity. With our present information, however, and after giving the subject our best consideration, we adhere to the opinion that a cannon of uniform tension as proposed by Mr. Mallet and recommended by Mr. Hart, is a physical impossibility.

PETERBOROUGH CATHEDRAL.

THE work of improvement, now becoming so general in our cathedral edifices, has extended to Peterborough, where several alterations which have recently been made, develope the beauties of that structure in a way that could hardly be imagined before. Some excellent metal-work has been introduced by Mr. Skidmore, of Coventry, for gas purposes, and decorations in colour about the choir add to the general effect. Among the latter may be noticed the painting of the apse ceiling, the general design of which illustrates the passage—"I am the vine; ye are the branches." The principal feature is a figure of our Lord—probably the largest and most important that has been painted on a church roof in modern times. It is on a gold ground, and in a sitting posture, comprised within a vesica form, upon which are powdered gold stars on a white ground. The figure is draped in crimson and white, with gold orphreys and yellow diapering. The aureole and orb are of gold. The figure, if erect, would stand about 16 feet high. From the sides of the geometrical form in which the figure sits spring vine-branches, arranged scroll-wise; these branches contain busts of the twelve apostles, six on either side; the colour of the groundwork upon which the busts and ornaments are painted, is of an azure blue.

The work has been carried out under the auspices of the cathedral architect, Mr. G. G. Scott, A.R.A., who has been ably seconded in the practical department by Mr. J. R. Clayton, the gentleman who has produced the fine work of art we have been noticing, and by Mr. Castell, of South Molton-street, who executed he scroll-work and subservient decorations.

JAMES MEADOWS RENDEL, F.R.S., C.E.

AT the Institution of Civil Engineers, on the 25th of November, on taking the chair Mr. Brunel announced to the meeting the decease of Mr. James Meadows Rendel, past President of the Institution, and proposed, as a mark of respect for the memory of the late distinguished member, to adjourn the meeting. This proposition was unanimously agreed to, several members availing themselves of the opportunity of expressing their respect and esteem for their late friend and their sympathy with his family for the heavy loss they had sustained.

The late Mr. J. M. Rendel was a native of the West of England, where he was practically instructed in the executive part of the profession, and was early selected by that acute observer of talent, Mr. Telford, for laying out and constructing considerable lengths of turnpike roads in Devonshire and Cornwall; and the difficulties he there encountered and overcame, tended much to give him that self-reliance so useful to him in his subsequent career. After being engaged in several large works in his native district, he undertook the construction of the cast-iron bridge over the river Lary, near Plymouth, at the express desire of the Earl of Morley, who had the discrimination to discover the latent talent of the young engineer, then only twenty-two years of age, and to his exclusive direction, with the approval of Mr. Telford, was intrusted the execution of that important work. It was commenced in the year 1824, and was completed in 1827. This was soon followed by the construction of the floating steam-bridge for crossing the estuary of the Dart, near Dartmouth, somewhat on the same principle as those subsequently established by him for crossing the Hamoaze, between Torpoint and Devonport, and later still those at Saltash, at Southampton, and at Portsmouth. He was engaged also in the distribution of the water mains at H. M. Dockyard, Plymouth, and on the water works at Edinburgh.

In the year 1838 he removed from Plymouth to London, and soon became extensively occupied on important works, and was engaged in the Parliamentary contests of that remarkable period in the history of engineering. Among the numerous works upon which he was occupied may be mentioned the Montrose Suspension Bridge; the Inverness Bridge; the Leith, and the East and West India and London Docks, where he designed and executed extensive improvements, amounting to partial reconstruction.

The design for the construction of Docks at Birkenhead, in Cheshire, of such an extent as to create a formidable rival to Liverpool, brought Mr. Rendel very prominently before the world, and the protracted contests on this subject will not only be long remembered in the history of Parliamentary Committees, but the evidence given by the projector and other engineers, as now collected, forms a valuable record of the state of engineering practice. The almost incessant labour, and the mental anxiety inseparable from this undertaking, were more than even his powerful constitution could support, and it is feared that they tended to shorten his valuable life.

The daring project of constructing a dock at Great Grimsby, by projecting the works far out upon the mud banks of the river Humber was next successfully accomplished; and he commenced the two great works which alone suffice to hand down his name to posterity, beside those of Smeaton, Rennie, and Telford—the Harbours of Refuge of Holyhead and Portland. Both these works were conceived with the largest views, and have been carried on with great rapidity. In both cases the system was adopted of establishing timber stages over the line of the jetties and depositing the masses of stone of all dimensions, by dropping them vertically from railway wagons into their positions; thus bringing up the mass simultaneously to above the level of the sea. In this manner, as much as 24,000 tons of stone have been deposited in one week, and to supply this vast demand, monster blasts of 5 or 6 tons of gunpowder were frequently employed. These two great works are progressing very satisfactorily, and it is worthy of remark, that although the severe storms which have repeatedly occurred on the exposed coasts where they are situated, have done some injury to portions of the stages, and of the temporary works, not a stone would appear to have been carried away from the jetties; and the success of the system may be said to be complete, in spite of the sinister predictions which prevailed before the system was tried.

Among the other works upon which Mr. Rendel was engaged, should also be mentioned the constructions on the river Lea, and

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the improvements of the Nene river; the latter a work of considerable difficulty, and not yet completed. He was also employed by the Exchequer Loan Commissioners to report upon the drainage and other public works in Ireland. He was less engaged in railways than in hydraulic works, but in England he executed the Birkenhead, Lancashire, and Cheshire Junction Line, and in India he had the direction of the "East Indian" and "Madras" Railways, the former projected by Mr. Macdonald Stephenson, as the first of the vast system now being formed, and which will work such a revolution in the destiny of the Indian empire. The Ceylon and the Pernambuco lines were also under his charge.

The limits of this short sketch preclude the possibility of enumerating more of the works upon which Mr. Rendel was engaged, and it would appear extraordinary how he could find time for such varied occupations, as, in addition to these active duties, he was very frequently called upon by the government to report on large works, the most implicit confidence being reposed in his truthfulness, the correctness of his views, and the fearless expression of his opinions. He was a man of great energy, clear perception, and correct judgment; his practical knowledge was well directed, and he knew how to make good use of the scientific acquirements and skill of all whose services he engaged. His evidence before Committees of the House was clear and convincing,—seldom failing in carrying his point,—and his reports on engineering works are so well conceived and drawn up, that it may be hoped they will be given to the world for the benefit of the profession. With these qualities, which were fully appreciated, it need scarcely be mentioned, that he rose rapidly to a very high position in his profession. He became a Fellow of the Royal Society, and was elected upon the Council; he was a very early member of the Institution of Civil Engineers, having joined it in 1824. He had been for the last sixteen years upon the Council, and held the post of President during the years 1852 and 1853.

He was as amiable and kind in private life as he was energetic and firm in public, and his decease, which occurred on the 21st November, cast a gloom over the whole of the profession of which he was a brilliant ornament.

WORKS OF THE LATE COMMENDATORE CANINA.

By T. L. Donaldson.

[*Abstract of a Paper read at the Royal Institute of British Architects, November 3rd.*]

I am not at this moment in possession of any authentic details connected with his early life and studies. I can only relate what I learned from himself casually from time to time while we were together, and my own impressions derived from his works.

The first important work of Canina, as an author, appears to be his "History of Ancient Architecture," divided into three series of Egyptian, Greek, and Roman; the second edition of which consists of three folio volumes of 705 plates, and nine volumes of text in 8vo.

About the year 1842, he visited Turin, where he remained three months, and being invited to give his ideas upon a proposed new church to be erected on the site of that of St. John in that city, he availed himself of the opportunity to develope at considerable length his opinions of the proper form of a Christian church, which he conceived to be that of the early Christian Basilica, like that of St. Paul's without the walls at Rome; not that he intended to adopt the type throughout every minute detail, but to assume that form as the basis. Moved by this great predilection of his, the Signor Canina, under the auspices of H. M. Carlo Alberto, King of Sardinia, published in 1843 a folio volume, which reviews the history, distinctive form, properties and decorations of the ancient Roman Basilicas.

Canina next devoted his studies to the immediate edifices of Rome and the Campagna, and published four vols. of plates, illustrating the former and two devoted to the Campagna, which were followed by a folio volume of type, as a topographical exposition of ancient Rome. He then entered upon the investigation of the important monuments of the Roman Forum, a subject which had been distracted by the contentions of the rival systems of French, German, and Italian antiquaries, and which had caused a strife that set all the archæologists by the ears. His next work was a topographical plan of the Campagna of Rome, full of profound research. He next turned his attention to Jerusalem, in a folio volume entitled "Researches upon the Architecture of the Ancient Jews and of the Temple of Jerusalem," and then resumed his Roman studies by a folio work of 53 plates upon ancient Tusculum, detailing the Villas, the Forum, the Theatre, and other antiquities which still remain upon that classic site.

But his researches were now to take in a more remote epoch, and to seek for illustrations in a field which has since, within the last twenty years, been so fruitful of evidences of the history of the earlier inhabitants of Italy; and which have brought to light antiquities, such as cities, city walls, tombs, vases, and other curious objects, dating prior to the foundation of Rome itself. The City of Veii has its folio volume of 45 plates, meant only for private distribution, and prepared at the expense of the Dowager Queen of Sardinia. Ancient maritime Etruria is described and demonstrated, with its monuments, in four folio volumes and 136 plates. These works introduce us to arts, buildings, and other monuments revealing influences of Greek origin, and developing a school anterior to the earliest of any of the Roman buildings. Our indefatigable author next published a folio volume of 40 plates upon domestic architecture, applying the most graceful forms of all ancient people to modern uses. Thus carrying out his great endeavour to throw as much of the ancient taste as he possibly could into the various productions of modern times, he sought to influence the mechanical arts, so as to lead to a revival of antique forms, dispositions and proportions.

His last, and it may truly be called, his "Opus Magnum," consists of two folio volumes, containing the results of his excavations on the old Via Appia for a distance of six miles from the walls of Rome to Boville, with the announced intention of soon continuing his publication from Boville to Ariccia, and which, doubtless, he would have fulfilled had he been spared to complete his grand scheme. Many will recall the vivid manner in which Mr. Tite, on his return from Rome in 1855, described the impressions produced on his mind, when, in company with Canina, he visited the successful results of his labours on the Via Appia. The tombs, the paved road, the mile-stones, the villas, the circi, the amphitheatres, the fora, and other important edifices, which the encumbered ruins, pile upon pile, were made to reveal to the labour and intelligence of our friend, on a scale little inferior to those, so well known to all of us, in Rome; not less rich in decoration, nor less novel in design —a mass of fresh inscriptions to illustrate still further ancient customs and ancient history. He published an enlarged supplementary edition of Desgodetz, and wrote numerous very important papers, which are inserted in the "Annali dell' Instituto Archeologico" of Rome.

The Commendatore Canina had travelled much throughout Europe, and studied on the sites themselves the monuments of Sicily and Greece proper. His recent visit to England was the second that he had made to this country. His researches and labours were appreciated by many Princes and Sovereigns, and he was decorated with a profusion of Orders of various countries. But the distinction which he valued most was the position he held as Director of the Museum of the Capitol, and the title of Commendatore, which ranked him among the forty nobles of Rome. This gave him just pride, as did also the Royal Gold Medal conferred upon him by this Institute, in 1849, with the approval of her Majesty and Prince Albert.

His decease will produce a great void in Rome, where his acquirements and judgment were fully valued. His opinion was a high authority on all matters of classic archæology, and many an artist recognised in him a judicious adviser and patron. He was naturally reserved, and slow to form friendships, being distrustful of the depth of quick attachments; but when once a friend, he continued so firmly and warmly, and thought no personal exertion or sacrifice too great to serve those he valued.

He was truly a giant in the archæological and architectural literature of classic antiquity; and however various may be the opinions of men upon his erudition and taste, all must agree, that he had great acuteness of perception on antiquarian subjects, and a very enlarged acquaintance with ancient art, for which he had the most supreme veneration, as also for the works of the masters of the fifteenth and sixteenth centuries. Although occasionally influenced by certain deep prejudices, particularly in regard to mediæval art, he has yet rendered essential service in the elucidation of the history of architecture. He has

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abridged the task of future labourers in that field of research, and left a body of information and instruction in his numerous tomes far beyond that produced by any other previous scholar. It would be difficult to find any more earnestly and disinterestedly devoted to the highest and noblest principles of our art.

SUBSTITUTE FOR IRON PIPES AND BRICK SEWERS.

THE heavy cost of iron mains or pipes, and the great expense of laying them in trenches under roads, together with their short duration (from oxidation), liability to flaws, fractures, defects in joints, &c., are disadvantages universally felt; and the interruption of traffic, consequent upon the almost constant repairs going on in the streets, is so serious an evil, that it is absolutely necessary some remedy should be devised, particularly in the metropolis. It is also now considered imperative that the public generally should be provided with a more copious supply, and better quality of water, than heretofore, and that the sewage should be quickly collected and as quickly removed. For the attainment of these objects, substantial and imperishable conduits or tunnels are essentially necessary. The iron pipes and brick sewers now in use are not adapted to the purposes—the first being costly, rapid in decay, and rendering the water impure; the last, although less costly, absorbing the sewage, and retaining much of the foul matters intended to be removed and discharged, and eventually becoming a mass of corruption. To provide a substitute, which shall be equal if not superior to the famed Roman conduits and aqueducts, has occupied the attention of Mr. William Austin for many years past, and he has at length produced and patented an imperishable and economical material in blocks of peculiar form, for the rapid construction of conduits, aqueducts, sewers, tunnels, well-pits, mine-shafts, towers, light-houses, and similar cylindrical constructions. The blocks are also available for walls of buildings in general; also for wharves, sea or river walls, docks and harbours; in which latter case a straight-faced block is provided, dovetailing in its bed and end joints (perforated if required), and forming a compact, immoveable, indestructible, rocky mass, proof against the action of salts, acids, frost, or fire.

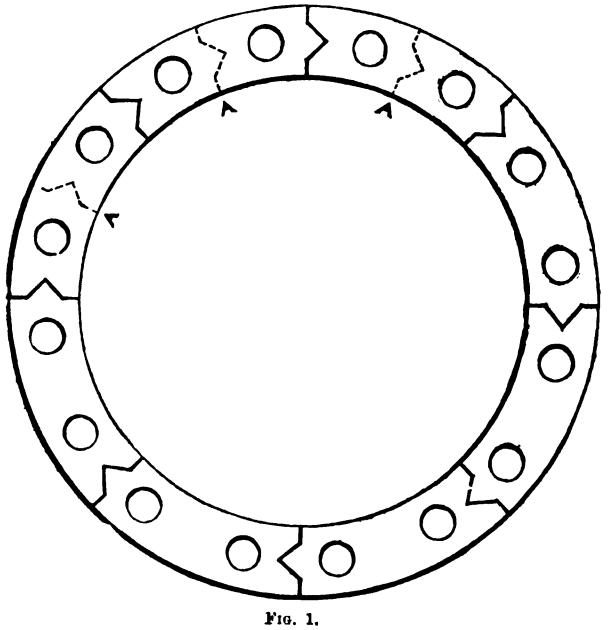
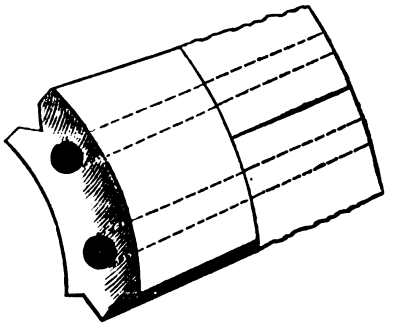


FIG. 1.

In the accompanying diagrams, fig. 1, when viewed vertically shows a plan of a tower or shaft, and viewed horizontally is a section of a tunnel, aqueduct, or conduit, formed of these blocks, showing at A, A, A, the bonding of alternate joints, as indicated by the dotted lines. The orifices come opposite to each other in succession, as seen in fig. 2, which is a perspective view of the circular blocks; and through the orifices, bolts, chains, dowels, or grout can be passed or run to act as ties. The blocks also dovetail in their ends or beds, as seen at B and C, figs. 3 and 4, securing additional strength and stability, and becoming a locked and immoveable structure, of a character somewhat similar to the vertebræ of animals.

FIG. 2.



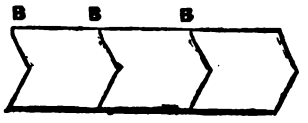


FIG. 3.

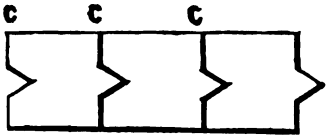


FIG. 4.

These blocks can be cut in a soft working stone, and then by induration be rendered intensely hard and impervious to moisture or frost; or the blocks can be formed in iron moulds from indurated pulp, made from sand, chalk, pebbles, gravel, brick-dust, road scrapings, and which, not requiring to be burnt in a kiln, are consequently not liable to torsion or twisting, but remain perfect fac-similes of the various iron moulds or shapes.

The application of these blocks has been suggested by Mr. Austin, in connection with his project (which has been laid before the Metropolitan Board and the public) for removing the whole of the metropolitan and suburban sewage by conduit tunnels under each shore of the Thames. All the sewage now discharges into the river: it would then, as proposed by him, be carried below each mud-bank without any interruption; and if the under-shore tunnels be extended from Fulham to the mouth of the Thames, every particle of the valuable sewage, when properly deodorised in its onward progress, would be eagerly sought for and applied to the poor and waste lands of Kent and Essex on each side of the river. Mr. Austin suggests boundary or limit-width walls for the Thames waters, having the conduit tunnels as footings for such walls, to prevent overflowing on each shore, and to redeem the waste marshes, converting them into corn and crop lands. Two important advantages would thus be combined—"the removal and useful application of sewage," and "the rendering the Thames a most handsome commercial river."

THE BERGEN TUNNEL, U.S. AMERICA.—This tunnel, 4300 feet in length, through the Bergen Hill, is about two miles from the city of Jersey on the New York and Erie Railroad,—the object being to afford a direct and independent approach to that city. The tunnel is cut directly through a ledge of hard trap rock by drilling and blasting, and its construction is a very formidable work. It will be 23 feet in height and 29 ft. 6 in. in width, affording ample space for two wide-gauge tracks. There are eight perpendicular shafts or openings from the tunnel to the surface, varying in depth from 70 to 90 feet. In five of them the bottom has been reached, and the drift (tunnel) commenced. The others are nearly ready for tunnelling. The eight shafts and two approaches will present eighteen faces where the rock can be assailed, and with two sets of men for day and night, eighteen different gangs can be employed, numbering, in all, about 1200 men. Near the opening of every shaft there is an engine of 35-horse power, to pump water, raise stone and inject fresh air. The large piles of stone near them show what has already been accomplished. So far as practicable, the debris is carried, by means of locomotives, to the proposed dock and depot ground between Jersey city and Hoboken, to assist in filling out the water front, which extends 1130 feet, and will form the bulk-head for six piers, 800 feet in length. Four steam-excavators are at work at this point. The construction of this tunnel was commenced last July, and is to be completed by the 15th of December, 1857.

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NOTES ON ACOUSTICS, WITH REFERENCE TO THE PUBLIC BUILDINGS OF THE UNITED STATES.

By J. Henry, LL.D., U.S.

At the meeting of the American Association, in 1854, I gave a verbal account of a plan of a lecture room adopted for the Smithsonian Institution, with some remarks on acoustics as applied to apartments intended for public speaking. At that time the room was not finished, and experience had not proved the truth of the principles on which the plan had been designed. Since then the room has been employed for two winters for courses of lectures to large audiences, and I believe it is the universal opinion of those who have been present that the arrangements for seeing and hearing, considering the size of the apartment, is entirely unexceptionable. It has certainly fully answered all the expectations which were formed in regard to it previous to its construction.

The President of the United States directed Capt. Meigs to confer with Prof. Bache and myself in regard to the acoustics of the new rooms in the ante-room of the Capitol.* Previous to this we first studied the peculiarities of the present hall of the House of Representatives. This is allowed to be one of the worst possible apartments for public speaking; and to determine the cause of the confusion of sounds which exists during debate, is of considerable importance in suggesting improvements in the arrangement of the new rooms. We afterwards examined the principal churches and halls in Philadelphia, New York, and Boston, and the peculiarities of these, as far as the investigation extended, may be referred to a few well-established principles of sound which have been applied to the construction of this lecture room. To apply them generally, however, in the construction of public halls requires a series of preliminary experiments.

In every small apartment it is an easy matter to be heard distinctly at every point; but in a large room, unless from the first in the original plan of the building provision be made on acoustic principles for a suitable form, it will be difficult, and indeed in most cases impossible, to produce the desired result. The same remark may be applied to lighting, heating, and ventilation, and to all the special purposes to which a particular building is to be applied. I beg, therefore, to make some preliminary remarks on the architecture of buildings bearing on this point, which, though they may not meet with universal acceptance, will, I trust, commend themselves to the common sense of the public in general.

In the erection of a building, the uses to which it is to be applied should be clearly understood, and provision definitely made for every desired object.

Modern architecture is not a fine art par excellence, like painting or sculpture; the object of the latter is to produce a moral emotion, or awaken the feelings of the sublime or the beautiful, and we egregiously err when we apply their productions to a merely utilitarian purpose. To make a fire screen of Rubens' Madonna, or a candelabrum of the statue of the Apollo Belvidere, would be to debase these exquisite productions of genius, and to do violence to the feelings of the cultivated lover of art. Modern buildings are made for other purposes than artistic effect, and in them the æsthetical must be subordinate to the useful; then the two may co-exist, and an intellectual pleasure be derived from a sense of adaptation and fitness, combined with a perception of harmony of parts and the beauty of detail.....The Greek architect was untrammelled by any condition of utility. Architecture was with him, in reality, a fine art. The temple was formed to gratify the popular deity. The minutest parts were exquisitely finished, since nothing but perfection on all sides, and in the smallest particular, can gratify an all-seing and critical eye. It was intended for external worship, and not internal use. It was without windows, and entirely open to the sky, or if closed with a roof the light was merely admitted through a large door. There were no arrangements for heating or ventilation. The uses, therefore, to which, in modern times, building of this kind can be applied, are exceedingly few; and though they were objects of great beauty, and fully realised the intention of the architect when originally constructed, yet they cannot be copied in our days without violating the principles which should govern in architectural adaptation.

Every vestige of ancient architecture which now remains on the face of the earth should be preserved with religious care; but to servilely copy those, and to attempt to apply them to the uses of our day, is as preposterous as to attempt to harmonise the refinement of civilisation of the present age with the superstition of the times of the Pharoahs. It is only when a building expresses the dominant sentiment of an age, when a perfect adaptation to its use is joined to harmony of proportions and an outward expression of its character, that it is entitled to our admiration. It has been aptly said that it is one thing to adopt a particular style, but a very different one to adapt it to the purpose intended. Architecture should not only change with the character of the people, and in some cases with the climate, but also with the material to be employed in construction. The introduction of iron and of glass requires an entirely different style from that which sprung from the canes of Egypt, the masses of marble from which the lintels of the Grecian temples were formed, or the introduction of brick by the Romans.

While sound, in connection with its analogies with light and in its abstract principles, has been investigated within the last fifty years with a rich harvest of results, few attempts have been successfully made to apply those principles to practical purposes. Though we may have a clear idea of the abstract operation of a law of nature, yet when the conditions are varied and the actions multiplied, the results frequently transcend our powers of logic, and we are obliged to appeal to experiment and observation, not only to assist in deducing consequences, but also to verify those which have been arrived at by logical deduction. Furthermore, though we may know the manner in which a cause acts to produce a given effect, yet in all cases we are obliged to ascertain the measure of effect under given conditions.

The science of acoustics as applied to buildings, perhaps more than any other, requires this union of scientific principles with experimental deductions. While on the one hand the simple deductions from the established principles of acoustics would be unsafe from a want of knowledge of the constants which enter into our formula, on the other hand empirical data alone are in this case entirely at fault; and of this any person may be convinced who will examine the several works written on acoustics by those who are deemed practical men.

Sound is a motion of matter capable of affecting the ear with a sensation peculiar to that organ. It is not in all cases simply a motion of the air, for there are many sounds in which the air is not concerned. For example, the impulses which are conveyed along a rod of wood from a tuning-fork to the teeth. When a sound is produced by a single impulse, or an approximation to a single impulse, it is called a noise—when a series of impulses, a continued sound, &c.; if the impulses are equal in duration among themselves, a musical sound. This has been illustrated by a quill striking against the teeth of a wheel. A single impulse from one tooth is a noise, from a series of teeth in succession a continued sound, and if all the teeth are at equal distances, and the velocity of the wheel is uniform, then a musical note is the result. Each of these sounds is produced by the human voice, though they apparently run into each other. Usually, however, in speaking, a series of irregular sounds of short duration are emitted—each syllable of a word constitutes a separate sound of appreciable duration, and each compound word and sentence an assemblage of such sounds. It is astonishing that in listening to a discourse the ear can receive so many impressions in the course of a second, and that the mind can take cognisance of and conquer them.

That a certain force of impulse, and a certain time for its continuance, are necessary to produce an audible impression on the ear, is evident; but it may be doubted whether the impression of a sound on this organ is retained appreciably longer than the continuance of the impulse itself,—certainly not longer than the one-tenth of a second. If this were the case it is difficult to conceive why articulate discourse which so pre-eminently distinguishes man from the lower animals, should not fill the ear with a monotonous hum; but whether the ear continues to vibrate, or whether the impression remains a certain time on the *sensorium*, it is certain that no sound is ever entirely instantaneous, or the result of single impression, particularly in enclosed spaces. Every impulse must give rise to a forward and afterwards to a backward motion of the atom. The impulse is not only communicated to the ear, but to all bodies around, which in turn, themselves become centres of reflected impulses.

Sound from a single explosion in air equally electric on all sides tends to expand equally in every direction; but when the

* See *Journal*, Vol. XVII. (1854) p. 161.

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impulse is given to the air in a single direction, though an expansion takes place on all sides, it is much more intense in the line of the impulse. For example, the impulse of a single explosion, like that of the detonation of a bubble of oxygen, is propagated equally in all directions; while the discharge of a cannon, while heard on every side, is much louder in the direction of the axis; so, also a person speaking is heard much more distinctly in front than at an equal distance behind. Many experiments have been made on this point, and I may mention those repeated in the open space in front of the Smithsonian Institution. In a circle one hundred feet in diameter, the speaker in the centre and the hearer in succession at different points of the circumference, the voice was heard distinctly directly in front, gradually less so on either side, until in the rear it was scarcely audible. The rates of distance for distinct hearing directly in front, on the sides, and in the rear, were about as 100, 75, and 30. These numbers may serve to determine the form in which the audience should be arranged in an open field, in order that those on the periphery of the space may all have a like favourable opportunity of hearing, though it should not be recommended as the interior form of an apartment, in which a reflecting wall would be behind the speaker.

The impulse-producing sound requires time for its propagation, and thus depends upon the intensity of repulsion among the atoms; and, secondly, on the specific purity of the matter itself. If the medium were entirely rigid, sound would be propagated instantaneously. The weaker the repulsion between the atoms, the greater will be the time required to transmit the motion from one to the other; and the heavier the atoms, the greater will be the time required for the action of a given force to produce in them a given amount of motion. Sound, also, in meeting an obstacle is reflected in accordance with the law of light, making the angle of incidence equal to the angle of reflection. The tendency, however, to a divergency in a single beam of sound, appears to be much greater than that in the case of light. The law, however, appears to be definitely observed in the case of all beams that are reflected in a direction near the perpendicular. It is on the law of the propagation and reflection of sound, that the philosophy of echo depends. Knowing the velocity of sound, it is an easy matter to calculate the interval of time which elapses between the original impulse and the return of the echo. Sound moves at the rate of 1125 feet in a second at the temperature of 60°. If, therefore, we stand at half this distance before a wall, the echo will return to us in one second. It is, however, a fact known from universal experience, that no echo is perceptible from a near wall, though one in all cases must be sent back to the ear; the reason of this is that the ear cannot distinguish the difference between the similar sounds, as, for example, that from the original impulse and its reflection, if they follow each other at less than a given interval, which can only be determined by actual experiment; and as this is an important element in the construction of buildings, the attempt was made to determine it with some considerable degree of accuracy. For this purpose the observer was placed immediately in front of the wall of the west end of the Smithsonian building, at the distance of 100 feet; the hands were then clapped together; a distant echo was perceived, —the elapsed time of the passage of the impulse from the hand to the ear, and that from the hand to the wall and back to the ear was sufficiently great to produce two entirely distinct impressions. The observer then gradually approached the building until no echo or perceptible prolongation of the sound was observed. By accurately measuring this distance, and doubling it, we find the interval of space within which two sounds may follow each other without appearing separated. But if two rays of sound reach the ear without having passed through distances differing from each other greater than this, they produce the effect of separate sounds. This distance we have called the limit of perceptibility in terms of space. If you divide this distance into the velocity of sound, we ascertain the limit of perceptibility in time.

In the experiment just made with the wall a source of error was discovered, in the fact that a portion of the sound returned was reflected from the cornice under the eaves, and as this was at a greater distance than the part of the wall immediately perpendicular to the observer, the moment of the cessation of the echo was less distinct. In subsequent experiments with a louder noise the reflection was observed from a perpendicular surface of about twelve feet square, and from this more definite results were obtained. The limit of the distance in this case was about thirty-five feet, varying slightly, perhaps, with intensity of the sound and the acuteness of different ears. This will give about one-sixteenth of a second as the limit of time at which the ear can separately distinguish two similar sounds. From this experiment we learn that the reflected sound may tend to strengthen the impression or to confine it, according as the difference of time between the two impressions is greater or less than the limit of perceptibility. An application of the same principle gives us the explanation of some phenomena of sound which have been considered mysterious. Thus, in the reflection of an impulse from the edge of a forest of trees, each leaf properly situated within a range of thirty feet of the front plane of reflection, will conspire to produce a distinct echo, and these would form the principal part of the reflecting surfaces of a dense forest, for the remainder would be screened, and being at a greater distance every ray which might come from them would serve to produce merely a low continuation of the sound.

On the same principle we may at once assert that the panelling of a room, or even the introduction of reflecting surfaces at different distances, will not prevent the echo, provided they are parallel to each other, and situated relatively to each other within the limit of perceptibility.

Important advantage may be taken of the principle of the reflection of sound by the proper arrangement of the reflecting surfaces behind the speaker. We frequently see in churches, as if to diminish the effect of the voice of the preacher, a mass of drapery placed directly in the rear of the pulpit. However important this may be in an æsthetical point of view, it is certainly at variance with correct acoustic arrangements—the great object of which should be to husband every articulation of the voice, and to transmit it unmingled with other impulses and with as little loss as possible to the ears of the audience.

Another effect of the transmission and reflection of sound is that which is called reverberation, which consists of a prolonged musical sound, and is much more frequently the cause of indistinctness of perception of the articulations of the speaker than the single echo.

Reverberation is produced by repeated reflection of a sound from the walls of the apartment. If, for example, a single detonation takes place in the middle of a long hall, with naked and perpendicular walls, an impulse will pass in each direction, will be reflected from the walls, cross each other again at the point of origin, be again reflected, and so on until the original impulse is entirely absorbed by the solid materials which confine it. The impression will be retained upon the ear during the interval of the transmission past it of two successive waves, and thus a continued sound will be kept up, particularly if the walls of any part of the room are within thirty-five feet of the ear. If a series of impulses, such as those produced by the rapid snaps of the teeth of a wheel against a quill, be made in unison with the echoes, a continued musical sound will be the result. Suppose the wheel to be turned with such velocity as to cause a snap at the very instant the return echo passes the point at which the apparatus is placed, the second sound will combine with the first, and thus a loud and sustained vibration will be produced. It will be evident from this that every room has a key note, and that if an instrument be sounded on this, it will resound with great force. It must be apparent also that the continuance of a single sound, and the tendency to confusion in distinct articulation will depend on several conditions—first, on the size of the apartment; second, on the strength of the sound, or the intensity of the impulse; third, on the position of the reflecting surface; and, fourth, on the nature of the material of the reflecting surfaces.

In regard to the first of these, the larger the room, the longer time will be required for the impulse to reach the wall along the axis; and if we suppose at each collision a portion of the original force is absorbed, it will require double the time to totally extinguish it in a room of double the size, because the velocity of sound being the same, the number of collisions in a given time will be inversely as the distance through which the sound has to travel.

Again, that it must depend upon the loudness of the sound, or the insecurity of the impulse, must be evident when we consider that the cessation of the reflections is due to the absorption of the walls or irregular reflection, and that consequently the greater the amount of original disturbance the longer will be the time required for its complete extinction. This principle was abundantly shown by our observations on different rooms.

Thirdly, the continuance of the resonance will depend upon the

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position of the reflecting surfaces. If these are not parallel to each other, but oblique, so as to reflect the sound, not to the opposite but to the adjacent wall, without passing through the longer axis of the room, it will evidently be sooner absorbed. Any obstacle also which may tend to break up the wave and interfere with the reflection through the axis of the room, will serve to lessen the resonance of the apartment. Hence, though the panelling, the ceiling, and introducing a variety of oblique surfaces, may not prevent an isolated echo, provided the distance be sufficiently great and the sound sufficiently loud, yet that they do have an important effect in stopping the resonance is evident from theory and experiment. In a room fifty feet square, in which the resonance of a single intense sound continued six seconds, where cases and other objects were placed round the wall, its continuance was reduced to two seconds.

Fourthly, the duration of the resonance will depend on the nature of the material of the wall. A reflection always takes place at the surface of a new medium, and the amount of this will depend on the elastic force or power to resist compression, and the density of the new medium. For example, a wall of nitrogen, if such could be found, would transmit nearly the whole of a wave of sound in air, and reflect but a very small portion. A partition of tissue-paper would produce nearly the same effect. A polished wall of steel, however, of sufficient thickness to prevent yielding, would reflect, for practical purposes, all the impulses through the air which might fall upon it. The rebound of the wave is caused not by the oscillation of the wall, but the elasticity and mobility of the air. A single ray of sound striking against a yielding board would probably increase the loudness of the reverberation, but not its continuance. On this point a series of experiments were made by the use of the tuning-fork. In this instrument the motion of the foot and of the two prongs give a sonorous vibration to the air, which, if received upon another tuning-fork of precisely the same size and form, would reproduce the same vibrations.

It is a fact well established by observation, that when two bodies are in perfect unison, and separated from each other by a space filled with air, the vibrations of the one will be transmitted to the other. From this consideration it is probable that very nearly the same effect ought to be produced in transmitting immediately the vibration of a tuning-fork to a reflecting body as to duration and intensity, as in the case of transmission through air. This conclusion is strengthened by floating a flat piece of wood in a vessel of water standing upon a sounding board; placing a tuning-fork on this, the vibrations will be transmitted to the board through the water, and sounds will be produced of the same character as those emitted when the tuning-fork is placed directly on the board. A tuning-fork was suspended from a fine cambric thread, vibrated in air, and, from the mean of a number of experiments, was found to continue in motion 252 seconds. In this experiment, had the tuning-fork been in a perfect vacuum, suspended without the use of a string, and further, had there been no etherial medium, the agitation of which would not give rise to light, heat, electricity, or some other form of etherial motion, the fork would continue its vibration for ever.

The fork was next placed upon a large thin pine board—the top of a table. A loud sound, in this case, was produced, which continued less than 10 seconds. The whole table, as a system, was thrown into motion, and the sound produced was as loud on the under side as on the upper side. Had the tuning-fork been placed upon a partition of this material, a loud sound would have been heard in the adjoining room; this was proved by sounding the tuning-fork against a door leading into a closed closet. The sound within was apparently as loud as that without.

The rapid decay of sound in this case was produced by the great amount of motive power of the fork being communicated to a large mass of wood. The increased sound was due to the increased surface. In other words, the shortness of duration was compensated for by the greater intensity of effect produced.

The tuning-fork was next placed upon a circular slab of marble, about 3 feet in diameter and ¾-inch thick; the sound emitted was feeble, and the undulations continued 115 seconds, as deduced from the mean of six experiments.

In all these experiments, except the one in a vacuum, the time of the cessation of the tuning-fork was determined by bringing the mouth of a resounding cavity near the end of the fork; this cavity having previously been adjusted to unison with the vibrations of the fork, gave an audible sound when none could be heard by the unaided ear.

The tuning-fork was next placed upon a cube of india-rubber, and this upon a marble slab. The sound emitted in this case was scarcely that in the case of the tuning-fork suspended from the cambric thread; and, from this analogy of the previous experiments we might at first thought suppose the time of duration would be great—but this was not the case: the vibrations continued only forty seconds. The question may here be asked, what became of the impulses lost by the tuning-fork? They were neither transmitted to the india-rubber, nor given off to the air in the form of sound, but were probably expended in producing a change in the matter of the india-rubber, or were converted into heat, or both. Though the inquiry did not fall strictly within the line of this series of investigation, yet it was of so interesting a character, in a physical point of view, to determine whether heat was actually produced, that the following experiment was made.

A cylindrical piece of india-rubber about 1¼ inch diameter, was placed in a tubulated bottle with two openings, one near the bottom and the other at the top; a stuffing-box was attached to the upper, through which a metallic stem, with a circular foot to press upon the india-rubber, was made to pass, air-tight. The lower tubular was closed with a cork, in a perforation of which a fine glass tube was cemented; a small quantity of red ink was placed in the hole to serve as an index. The whole arrangement thus formed a kind of thermometer which would indicate a certain amount of change of temperature in the inclosed air. On the top of the stem the tuning-fork was screwed, and consequently its vibrations were transmitted to the rubber within the bottles. The glass was surrounded with several coatings of flannel to prevent the influence of the external temperature. The tuning-fork was then sounded, and the vibrations were kept up for some time. No reliable indications of an increase of temperature were observed. A more delicate method of making the experiment next suggested itself. The tube containing the drop of red ink, with its cork, was removed, and the point of a compound wire formed of copper and iron was thrust into the substance of the rubber, whilst the other ends of the wire were connected with a delicate galvanometer. The needle was suffered to come to rest. The tuning-fork was then vibrated, and its impulses transmitted to the rubber. A very perceptible increase of temperature was the result. The needle moved through an arc of from one to two and a half degrees. The experiment was varied, and many times repeated; the motions of the needle were always in the same direction, viz.—in that which was produced when the point of the compound wire was heated by momentary contact with the fingers. The amount of heat generated in this way is, however, small, and indeed, in all cases in which it is generated by mechanical means, the amount evolved appears very small in comparison with the labour expended in producing it. Joule has shown that the mechanical energy generated in a pound weight, by falling through a space of 750 feet, elevates the temperature of a pound of water one degree.

It is evident that an object like india-rubber actually destroys a portion of the sound, and hence in cases in which entire non-conduction is required, this substance can probably be employed with perfect success.

The tuning-fork was next pressed upon a solid brick wall; the duration of the vibration, from a number of trials, was eighty-eight seconds. Against a wall of lath and plaster the sound was louder, and continued only eighteen seconds.

From these experiments we may infer that if a room were lined with a wainscot of thin boards, and a space left between the wall and the wood, the loudness of the echo of a single noise would be increased, while the duration of the echo would be diminished. If, however, the thin board were glued or cemented in solid connection with the wall, or embedded in the mortar, then the effect would be a feeble echo, and a long-continued resonance similar to that from the slab of marble. This was proved by first determining the length of continuance of the vibrations of a tuning-fork on a thin board, which was afterwards cemented to a flat piece of marble.

A series of experiments were next commenced with reference to the actual reflection of sound. For this purpose a parabolic mirror was employed, and the sound from a watch received on the mouth of a hearing-trumpet, furnished with a tube for each ear. The focus was near the apex of the parabola, and when the watch was suspended at this point it was six inches within the plane of the outer circle of the mirror. In this case the sound was confined at its origin and prevented from expanding. No

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conjugate focus was produced, but, on the contrary, the rays of light, when a candle was introduced, constantly diverged. The ticking of the watch could not be heard at all when the ear was applied to the outside of the mirror, while directly in front it was distinctly heard at the distance of thirty feet, and, with the assistance of the ear-trumpet, at more than double that distance. When the watch was removed from the focus the sound ceased to be audible. This method of experimenting admits of considerable precision, and enables us to directly verify, by means of sound transmitted through air, the results anticipated in the previous experiments. A piece of tissue paper placed within the mirror, and surrounding the watch without touching it, slightly diminished the reflection. A simple curtain of flannel produced a somewhat greater effect, though the reflecting power of the metallic parabola was not entirely masked by three thicknesses of flannel, and I presume very little change would have been perceived had the reflector been lined with flannel glued to the surface of the metal. The sound was also audible at the distance of ten feet, when a large felt hat, without stiffening, was interposed between the watch and the mirror. Care was taken in these experiments so to surround the watch that no ray of sound could pass directly from it to the reflecting surface.

With a cylindrical mirror with parabolic base very little increased reflection was perceived. The converging beams were merely in this case in a simple plane perpendicular to the mirror, and passing through the ear, while to the focal point of the spherical mirror a solid cone of rays was sent.

The reflection from the cylindrical mirror forms what is called a "caustic" in optics, while that from a spherical mirror gives a true focus; or, in other words, collects the sound from all parts of the surface and conveys them to one point of space. These facts furnish a ready explanation of the confusion experienced in the Hall of Representatives, which is surmounted by a dome, the under surface of which acts as an immense concave mirror, reflecting to a focus every sound which ascends to it, leaving other points of space deficient in sonorous impulses.

Water and other liquids, which offer great resistance to compression, are good reflectors of sound. This may be shown by the following experiment:—When water is gradually poured into an upright cylindrical vessel, over the mouth of which a tuning-fork is vibrated until it comes within a certain distance of the mouth, it will reflect an echo in unison with the vibrations of the fork, and produce a loud resonance. This result explains the fact, which had been observed with some surprise, that the duration of the resonance of a newly-plastered room was not perceptibly less than that of one which had been thoroughly dried.

There is another principle of acoustics which has a bearing on this subject. I allude to the refraction of sound. It is well known that when a ray of sound passes from one medium to another, change in velocity takes place, and consequently a change in the direction or refraction must be produced. The amount of this can be readily calculated where the relative velocities are known. In rooms heated by furnaces, and in which streams of heated air pass up between the audience and speaker, a confusion has been supposed to be produced, and distinct hearing interfered with by this cause. Since the velocity of sound in air at 32 degrees of Fahrenheit has been found to be 1090 feet in a second, and since the velocity increases 1·14 feet for every degree of Fahrenheit, if we know the temperature of the room and that of the heated current, the amount of angular refraction can be ascertained. But since the ear does not readily judge of the difference of direction of two sounds emanating from the same source, and since two rays do not confuse the impression which they produce upon the ear, though they arrive by very different routes, provided they are within the limit of perceptibility, we may therefore conclude that the indistinctness produced by refraction is comparatively little. Professor Bache and myself could perceive no difference in distinctness in hearing from rays of sound passing over a chandelier of the largest size, in which a large number of gas jets were in full combustion. The fact of disturbance from this cause, however, if any exist, may best be determined by the experiment with a parabolic mirror and the hearing-trumpet before described.

These researches may be much extended; they open a field of investigation equally interesting to the lover of abstract science and to the practical builder. And I hope, on behalf of the committee, to give some further facts with regard to this subject at another time.

I will now briefly describe the lecture room, which has been constructed in accordance with the facts and principles stated above, so far, at least, as they could be applied.

There was another object kept in view in the construction of this room besides the accurate hearing—the distinct seeing. It was desirable that every person should have an opportunity of seeing the experiments which might be performed as well as hear distinctly the explanation of them.

By a fortunate coincidence of principles, it happens that the arrangements for ensuring unobstructed sight do not interfere with those necessary for distinct hearing.

The law of Congress authorising the establishment of the Smithsonian Institution directed that a lecture room should be provided, and accordingly in the first plan one half of the first story of the main building was devoted to this purpose. It was found, however, impossible to construct a room on acoustic principles in this part of the building, which was necessarily occupied by two rows of columns. The only suitable place which could be found was therefore on the second floor. The main building is 200 feet long and 50 feet wide; but by placing the lecture room in the middle of the story a greater width was obtained by means of the projecting towers.

The main gallery is in the form of a horse-shoe, and occupies three sides of the room. The speaker's platform is placed between two oblique walls. The corners of the room which are cut off by these walls afford recesses for the stairs into the galleries. The opposite corners are also partitioned off so as to afford recesses for the same purpose.

The ceiling is twenty-five feet high, and therefore within the reach of perceptibility. It is perfectly smooth and unbroken, with the exception of an oval opening near the platform, through which light is admitted.

The seats are arranged in a curved form, and were intended to rise in accordance with the panoptic curve originally proposed by Professor Bache, which enables every individual to see over the head of the person immediately in front of him. The original form of the room, however, did not allow of this intention being fully realised, and therefore the rise is somewhat less than the curve would indicate. The general appearance of the room is somewhat fan-shaped, and the speaker is placed as it were in the mouth of an immense trumpet. The sound directly from his voice, and that from reflection immediately behind him, is thrown forward upon the audience, and as the difference of the distance travelled by the two rays is much within the limit of perceptibility, no confusion is produced by direct and reflected sound. No echo is given off from the ceiling, for this is also within the limit of perceptibility, while it assists the hearing in the gallery by the reflection to that place of the oblique rays.

Again, on account of the oblique walls behind the speaker, and the multitude of surfaces, including the gallery pillars, stair-screens, &c., as well as the audience, directly in front, all reverberation is stopped.

The walls behind the speaker are composed of lath and plaster, and therefore have a tendency to give a more intense, though less prolonged sound than if of solid masonry. They are also intended for exhibiting paintings and drawings to the best advantage.

The architecture of this room is due to Captain Alexander, of the corps of Topographical Engineers. He fully appreciated all the principles of sound which I have given, and varied his plans until all the required conditions, as far as possible, were fulfilled.

Conversion of Peat into Coal. — A French engineer in the Russian service, it is said, has succeeded in discovering a process for converting common peat into a coal similar in every respect to anthracite. Persons who have seen specimens of this artificial mineral, state that it is equal in intensiveness of heat to common coal, while the cost of its production is sixty per cent. less. It is also available for making gas (1000 kilogrammes will produce 5400 cubic feet of gas), coal-tar, ammoniac, alcohol, coke, and volatile oils. The discoverer has obtained an exclusive patent for the Russian dominions. A company on a large scale is being formed at St. Petersburg for the purpose of working the patent, and establishing agencies throughout the whole of the Russian empire.

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REPORT ON THE WORKS OF THE METROPOLITAN WATER COMPANIES.

By HENRY AUSTIN, WILLIAM RANGER, and ALFRED DICKENS,
Superintending Inspectors of the General Board of Health—(July 1856.)

THE GRAND JUNCTION WATER COMPANY.

THE WORKS IN 1850.

Source of Supply.—The Company was incorporated to exercise powers of water supply originally granted to the Grand Junction Canal Company, and at first distributed water taken from that canal. In 1821-22 they changed their source of supply to the river Thames. In effecting this alteration, the mouth of the intake culvert-pipe was placed in close proximity to the outlet of the Ranelagh sewer in the river. In 1834 a further change was made, and a point higher up, on the Surrey side of the Thames, 360 yards above Kew-bridge, was selected, where the stream is separated from the Brentford or Middlesex side of the river by an ait commencing about 150 yards above Kew-bridge, and extending in length nearly half a mile. The water, after passing through an iron pipe, laid down in the bed of the river, was received into a well 8 feet diameter, and about 22 feet in depth, whence it was pumped into a depositing reservoir.

Reservoirs.—The total capacity of the reservoirs and filter beds (five in number) was 17,900,000 gallons, arranged as follows:

Depositing reservoirs at Kew-bridge	5,000,000
Filter beds at ditto	3,500,000
Store reservoir at Campden-hill	6,000,000
Store reservoir at Paddington	3,400,000

The reservoir at Paddington, which is about 89 feet above the level of Trinity high-water mark, was lined with brick, and the bottom coated with gravel.

Filtration.—The filter beds adjoining the depositing reservoirs at Kew-bridge contained an area of 70,078 superficial feet. The water in the filter beds varied in depth from 3 to 7 feet, as it was required; but all the water passed through the filter before it was pumped into the service reservoirs and mains for distribution. The filtering medium consisted of layers of gravel and sand arranged in the following order—viz.:

	ft.	in.	
1. Rough gravel that will not pass through a screen of 2-inch mesh	0	7½	thick.
2. Gravel that will not pass through a screen of 1-inch mesh	0	6	,,
3. Gravel that has passed through the screen of 1-inch mesh	0	9	,,
4. Small shells	0	1½	,,
5. Coarse sharp sand	0	6	,,
6. Fine sharp sand	1	6	,,
Total thickness of filtering medium	4	0	

Engine Power.—The total amount of steam power was equal to about 840 horses, comprised in seven engines, as follows:

1. Grand Junction engine,		300	horse power.
2. Mandslay's	do.	130	,,
3. East Cornish	do.	130	,,
4. West Cornish	do.	130	,,
5. Paddington	do.	70	,,
6. North filter	do.	40	,,
7. South filter	do.	40	,,

Mains and Branches.—The length of the iron mains and branches was about 80 miles 1 furlong and 17 yards, and the sizes varied from 30 inches diameter to three inches.

Quantity of water pumped—The total quantity of water pumped for supplying the district from the 1st October 1848 to 29th September 1849 was 1,289,184,930 gallons. The daily quantity delivered per house, including all purposes, appears to have been nearly 255 gallons.

Tenements supplied.—The number of tenements supplied with water, including those on the high service, and trades and large consumers, was 14,058; of these no less a number than 11,485 were rated under 5*l.* per annum, and about 200 were large consumers. The supply was given every day, except Sunday, throughout the whole of the Company's district. The highest service afforded by the Company, was about 150 feet above Trinity high-water mark, and the lowest 12 feet above that level.

Cost of the Works.—The total expenditure, up to December 1849, amounted to 522,295*l.* 4*s.* 9*d.*

RECENT ALTERATIONS AND ADDITIONS.

New Source of Supply.—The river Thames at Hampton at the point whence the Southwark and Vauxhall Company and the West Middlesex Company draw their supplies, a quarter of a mile above Hampton village, six miles above Teddington Lock and 26 miles above London-bridge. The water was first supplied from the new source by the Grand Junction Company on the 7th August 1855.

Works at Hampton.—The intake from the river is 2 ft. 6 in. below the maximum summer level. It is not in the main channel, there being an ait opposite the works which somewhat protects the water from the disturbance of barges and other traffic. The water has to pass three sets of galvanised iron strainers of different sized mesh before entering two subsiding reservoirs, of 45,000 superficial feet each, and capable of holding from six to ten million gallons, the actual quantity contained in them varying with the height of the stream. The water flows from these reservoirs to the pumping well.

The engine-power consists of two Cornish engines of 110 horse-power each. The cylinders are 60 inches in diameter with a 10-feet stroke. The poles are 42 inches in diameter with a 10-feet stroke. There is a stand pipe 90 feet high, to the top of which the engineers are calculated to raise twenty-two million gallons of water in twenty-four hours.

These works are connected with the Company's distributing works at Kew-bridge by a main of 33 inches in diameter, and about 13,500 yards in length. It passes through Twickenham, Isleworth, and Brentford.

Works at Kew and Kensington.—The reservoirs and filter beds at Kew remain the same in number as before, but they have been enlarged. The two reservoirs cover an area of 245,000 superficial feet, affording about three days' subsidence, and the three filter beds comprise 225,000 superficial feet. The filtering medium now consists of—

1. Harwich sand.....from 3 to 4 feet thick.
2. Fine gravel ..... 1 foot thick.
3. Fine screened gravel ..... 9 inches thick
4. Rough screened gravel ..... 9 inches thick
5. Coarse gravel ..... 1 foot thick.

The bottom layer is formed to a current each way to the lines of drains on a concrete floor.

The Company possesses at Kew a large area of spare land for additional works when required.

The open service reservoir at Campden-hill, Kensington, is now being covered (in compliance with the provisions of the Metropolis Water Act, 1852), it being within a distance of five miles from St. Paul's Cathedral. The covering consists of perforated brick arches 9 inches in thickness, 20 feet span, springing from girders supported on iron columns, The arches are covered with asphalte, upon which a thickness of soil will be laid and sown with grass. This reservoir has now an area of 46,800 square feet, with 22 feet depth of water. The cost of the covering will be 8000*l.*

Two engines, with 70-inch cylinders, and of the aggregate power of 300 horses, with nine boilers, and stand pipe of 150 feet high, are in course of erection at Campden-hill, and there will be space in the engine-house for a third similar engine. The height of service from the stand pipe will be 250 feet above Trinity high-water mark. It is expected that the whole of the works at Campden-hill will be completed by Midsummer next year.

One additional engine, of 150 horse-power, and four additional boilers, are in progress of erection at Kew, making a total engine-power of 920 horses, and eleven boilers, at that spot.

The reservoir and engine at Paddington have been abolished.

Mains and Branches.—The mains and branch pipes of this Company now measure about 117 miles; 37 miles having been laid since the previous return. The plan of the mains and direct mains, required by the 17th section of the Metropolis Water Act, 1852, is complete. It is laid down to a scale of 12 inches to the mile.

Consumption of Smoke.—No apparatus has been adopted at Kew for the consumption of the smoke of the furnaces. Very perceptible smoke was emitted from the chimney at the time of inspection, but it was not dense.

Quantity of Water Supplied.—The mean supply to the district during last year was 6,714,292 gallons, per day, distributed throughout the whole of the district daily, and the number of tenements now supplied amounts to 17,221.

Total Cost of the Works.—The cost of the additional works executed since the passing of the Acts of 1852 had amounted, on the 31st March 1856, to the sum of 166,128*l.* To this amount, however, should be added the contracts in actual execution, amounting to 45,000*l.*, which will make with the previous outlay, a total expenditure of 733,423*l.*

General Remarks.

The new buildings of the Grand Junction Company at Hampton, as well as of the Southwark and Vauxhall, and the West Middlesex Companies, are of Italian design, executed in white brick with stone dressings. They consist of engine and boiler-houses, cottages for the workmen, and a square tower which contains the chimney and a stand-pipe, 90 feet high, 4 ft. 6 in. in diameter. It is proposed to burn Welsh coal in the furnaces, but Newcastle coal having hitherto been used, the ornamental tower is somewhat disfigured by smoke.

The most noticeable part of the works at Hampton, are the direct acting engines, erected by Harvey and West, which are working steady and well. They are nominally of 100 horse-power, but work up to 110.

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It is proposed to pump eleven hours per day, twelve strokes per minute in ordinary work, fourteen strokes in full work. The water was turbid at the time of the inspection at Hampton, owing to recent rains. The filtered water at Kew was however bright, and pleasant to drink. The time of cleansing the filter beds varies from a few days to eight weeks, according to the state of the river. Considerable attention is paid to the washing of the sand for filtration; the operation costs 8½*d.* per cubic yard. With two feet head of water on the filter beds, about three gallons per hour pass through each square foot when in good working order.

The reservoir at Campden-hill, Kensington, is at present the only reservoir of this Company for filtered water. The works in this place described in the return were not completed, but were in rapid progress. In the meantime the supply for the whole of the district is pumped directly into the distributing mains.

The Company has purchased land at Shoot-up-Hill, near Hampstead-heath, at an elevation of 262 feet above the Thames, for the formation of another large reservoir.

The whole of the new works of this Company appear to be most efficiently carried out with a due regard to economy.

SOUTHWARK AND VAUXHALL WATER COMPANY.

Works in 1850.

Source of Supply.—The Company took its supply of water from the river Thames, near the Red-house, Rattersea, by means of a galvanised iron pipe 4 feet in diameter, laid to the full current of the river, considerably below low-water mark. The water was admitted first into a subsiding reservoir, from which it passed into a second, and thence into two filter beds, from which a 4-feet iron culvert conducted it to the pumps at the engines. It was then forced over stand pipes to the height of 185 feet above Trinity high-water mark, into the mains for distribution.

Reservoirs.—The capacity for the two depositing reservoirs and two filter beds at Battersea was equal to 43,000,000 gallons, the depositing reservoirs being capable of holding 32,000,000 gallons, and the filter beds 11,000,000 gallons. The area of the reservoirs and filter beds amounted to 491,000 superficial feet, and depositing reservoirs having a surface of 370,000, feet, and the filter beds 121,000 feet.

Filtration.—The only parliamentary obligation to which the Company was subject as to the quality of the water supplied was, that it should be filtered; they, however, made arrangements for securing the best supply practicable from that source by taking water only during the ebb tide.

The filtering medium was 5 ft. 6 in. thick, and consisted of—

1. A layer of clean sharp *river* sand, 2 feet thick.
2. A layer of fine gravel, 1 foot thick.
3. A layer of fine screened gravel, 9 inches thick.
4. A layer of rough screened gravel, 9 inches thick.
5. A layer of coarse gravel, 1 foot thick.

This bottom layer was formed to a current each way to the lines of drains on a concrete floor.

Engine Power.—The steam power of the four engines employed amounted nominally to about 355 horses.

1. Engine, cylinder 64 inches diameter; stroke 10 ft. 6 in.
   ,, pumps 32 inches diameter; stroke 10 feet.
2. Engine, cylinder 64 inches diameter; stroke 11 ft. 8 in.
   ,, pumps 33¼ inches diameter; stroke 10 ft. 6 in.
3. Engine, cylinder 31 inches diameter; stroke 6 ft. 3 in.
   ,, pumps 21¼ inches diameter; stroke 3 ft. 7½ in.
4. Engine, combined cylinders 24 and 40 inches diameter, with an 8-feet stroke.
   ,, pumps 60 inches diameter; stroke 8 feet.

Mains and Branches.—The length of mains, branches, and services amounted to about 380 miles.

Quantity of Water Pumped.—The total quantity of water pumped during the year 1849 was 2,195,006,370 gallons. The highest service afforded by the Company, was about 150 feet above Trinity high-water mark, and the lowest service below high-water.

Tenements Supplied.—The number of tenements supplied was 34,864, of which about 1000 were on the main, and had nearly a constant supply. The number of large consumers was 647. The average quantity delivered to each dwelling house, for seven days in the week, was 143 gallons per diem. The supply of water was given daily throughout the whole of the Company's district.

Cost of Works.—The total expenditure on the works up to December 1849 was 435,247*l.*

Recent Alterations and Additions.

Source of Supply.—The river Thames at Hampton, at the point where the Grand Junction and the West Middlesex Companies draw their supplies. The water was first supplied by the Southwark and Vauxhall Company from this source on the 19th July 1855.

Works at Hampton.—The intake from the river adjoins that of the Grand Junction Company, and the water passes through three sets of strainers, as before described, into two subsiding reservoirs of 45,000 superficial feet each, and capable of holding from six to ten million gallons, the actual quantity varying with the height of the stream.

The engine power at Hampton consists of two Cornish engines, built by Harvey and West, of 110 horse-power each. The cylinders are 60 inches in diameter, with 10 feet stroke. The poles are 42 inches in diameter, with 10 feet stroke. There is a stand pipe 90 feet high, to the top of which the engines are calculated to raise 22 million gallons of water in 24 hours. Four cottages have been erected for enginemen, &c. The main at Battersea is 36 inches in diameter, and about 23,000 yards in length. It passes through Twickenham, under the Thames, and then through Richmond, Putney, and Wandsworth to Battersea. It is connected with the Grand Junction Company's main at Hampton, and with the West Middlesex Company's main at Mortlake, for mutual aid in case of accidents.

Filter Beds and Works of Distribution at Battersea.—The two reservoirs of deposit and subsidence at Battersea are of the aggregate capacity of 20 million gallons. One circular filter bed of 75,000 superficial feet has been added to the works. The whole of the filtering beds are now capable of filtering an aggregate of 18 million gallons per diem. From one to two feet of sharp sand have been added to the former thickness of the filtering medium already described. Harwich sand is now chiefly used.

A Cornish engine of 170-horse power has been substituted at Battersea for the old lifting engine of 30-horse power, formerly used for raising the water directly from the river, which is no longer required. Two new boilers have been added, making a total of eleven. An engine-house is built, and ready to receive an additional engine of 350-horse power, with 112-inch cylinder, and 50-inch pump.

Mains and Branches.—The total length of pipeage now amounts to about 432 miles. The plan of the mains and district mains, required by the 17th section of the Metropolis Water Act, 1852, is complete. It is drawn to a scale of 100 feet to the inch.

Consumption of Smoke.—No apparatus has been adopted for the consumption of smoke of the furnaces. Welsh coal is now used.

Quantity of Water Supplied.—The mean supply of water to the district during the year 1855, was 10,331,122 gallons per day. The supply is given daily, for six days in the week, and two million gallons are furnished on Sundays. The number of tenements now supplied amounts to 41,529, including 641 large consumers.

Total Cost of the Works.—The cost of the additional works executed under the Acts of 1852 has amounted to 186,510*l.* To this sum should be added the contracts in actual execution, which amount to 27,500*l.*, making, with the previous outlay, a total expenditure of 649,257*l.*

General Remarks.

It will be seen from the foregoing returns that the works of this Company at Hampton are precisely similar to those of the Grand Junction Company, with the exception of the size of the mains for conveying the water thence to the works at Kew and Battersea.

The new direct-acting engine of 170-horse power, erected at Battersea, is contained in the building which formerly held the 30-horse engine used for lifting the water from the river to the contiguous reservoirs. The new engine occupies less space than the former one, although of such increased power. The whole of the new works appear to have been well and economically carried out.

The filtered water at the Battersea Works was bright and pleasant to drink, notwithstanding the turbid state of the river. This Company has no reservoir of filtered water. The supply is pumped direct over the stand pipes into the mains for the service of the district. Land has been purchased, however, for reservoirs at Nunhead, Peckham, at a level of 210 feet above high-water mark.

The connection between the river and the reservoirs at the Battersea Works, by which the supply was formerly obtained, has not yet been actually removed, but a dam has been put across to prevent the use of this intake.

The company not having taken sufficient precaution to prevent the issue of dense smoke from the furnaces at Battersea, were, on one occasion, fined 5*l.* for offending in this respect. Welsh coal is now used. A greater body of smoke than is usually due to Welsh coal was emitted during the inspection, but it could not be called dense.

THE WEST MIDDLESEX WATER COMPANY.

Works in 1850.

Source of Supply.—The Company obtained their supply of water from the river Thames, near Barnes-terrace, in the parish of Barnes, about ten miles above London-bridge.

Reservoirs.—The water passed into two subsiding reservoirs, comprising an area of about 16 acres. It was led through a duct from the Thames first into the western and thence into the eastern reservoir. These reservoirs were also partially supplied with water through the gravelly beds of the district. From the lower reservoir the water was

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conveyed by means of a 36-inch iron pipe across the bed of the river to the pumping-well on the Middlesex side. In addition to these subsiding reservoirs the Company had in use two service reservoirs, situate at Kensington, and at Barrow-hill, that at Kensington being capable of containing 3,450,000 gallons, and that at Barrow-hill 4,752,000 gallons. The Kensington reservoir is 111 feet above the level of Trinity high-water mark. The Barrow-hill reservoir is 177 ft. 6 in. above the same level. The highest service afforded by the Company, was 207 feet above Trinity high-water mark, and the lowest about 20 feet.

Filtration.—The water was not filtered. Its freedom from matter in suspension was dependent solely on subsidence in the reservoirs.

Engine Power.—The nominal power of the three engines at Hammersmith was 245 horses:

1. Engine 54-inch cylinder, 8 feet stroke.
   ,, pump, 20 inches diameter, 8 feet stroke.
2. Engine 54-inch cylinder, 8 feet stroke.
   ,, pump, 20 inches diameter, 8 feet stroke.
3. Engine 64-inch cylinder, 8 feet stroke.
   ,, pump, 28 inches diameter, 8 feet stroke.

Mains, Branches, &c.—The total length of mains, branches, and service pipes was about 150¼ miles; they varied in diameter from 30 inches to 3 inches.

Quantity of Water Pumped.—The total quantity of water pumped in the year 1849 was 1,216,929,812 gallons; about 144 gallons having been delivered to each house per diem.

Tenements Supplied.—The number of houses supplied by the Company was 24,480. The instances in which parties had pipes on the mains were very rare, and there were very few large consumers: the district is almost exclusively one of houses. The supply was given in all cases three times a week, and more frequently in parts of the district where it was required.

Cost of the Works.—The total cost of the works to the end of the year 1849 was 648,560*l.* 6*s.* 1*d.*

RECENT ALTERATIONS AND ADDITIONS.

Source of Supply.—The river Thames at Hampton, near the point whence the Southwark and Vauxhall, and Grand Junction Companies draw their supplies. Water was first supplied to the Company's district from this source on the 19th July 1855.

Works at Hampton.—The intake from the river is separate from those of the other two Companies. It is provided with a double set of wire screens, and is further protected at the mouth by a line of sheet piling in the river, which keeps off all floating substances. There is no subsiding reservoir in connection with these works, as with the contiguous works of the two other Companies. The water flows direct from the river to the engine well, through a pipe 4 feet in diameter; the supply can be stopped by means of sluices. The water is pumped direct to Barnes, a distance of about 8¾ miles. The diameter of the main is 36 inches. It runs parallel with the Southwark and Vauxhall main as far as Mortlake, whence it diverges to Barnes. The engine-power consists of two Cornish engines, direct action, with 64-inch cylinders and 10 feet stroke; the poles are 45 inches in diameter with 10 feet stroke.

Filter Beds, &c., at Barnes.—The water from Hampton is delivered into the two subsiding reservoirs at Barnes, which were previously used for the subsidence of the water drawn from the Thames at that point: these contain about six days' supply. Three filter beds have been constructed at Barnes, each comprising 1¼ acre in superficial area (sand surface). The filtering medium is 4 ft. 6 in. in depth, and is composed of 2 ft. 9 in. Thames sand; 1 ft. 9 in. hoggin and gravel of various sizes; total, 4 ft. 6 in. The water passes from the filter beds into a pure water well, whence it is conducted as before to the engines on the other side of the river. Filtered water was first supplied on the 27th March 1854.

Service Reservoirs.—It is proposed to abandon the service reservoir at Kensington, in order to save the cost of covering it, it being within the five-mile radius limited by the Metropolis Water Act, 1852. The service reservoir at Barrow-hill, Regent's-park, which comprises an area of 1¾ acre, has been covered with a series of hollow brick arches, 6 inches thick, of 20 feet span and 3 feet rise, springing from cross arches constructed on brick piers. The depth of the reservoir is 20 feet. The lower portion of the district is supplied direct from the distributing mains, without the intervention of any reservoir: the higher portion is supplied from the service reservoir at Barrow-hill, which is filled from the main by night.

Engine Power.—In addition to the new engines at Hampton already described, a new engine has been erected at Hammersmith, with 72-inch cylinder, 10 feet stroke, and a double action pump, 23 inches diameter. Two new boilers have also been added. A new engine has also been erected at Barrow-hill, 16-inch cylinder, 5 feet stroke, for the purpose of supplying a part of the district above this reservoir. The total of the engines of this Company may now be taken at 480 nominal horse-power.

Mains, Branches, &c.—The total length of pipesage now laid is about 178 miles; about 28 miles have been laid since the return made in 1850. A plan of the Company's under-ground works, to a scale of 5 feet to the mile, has been prepared in accordance with the Metropolis Water Act, 1852, and is now in course of correction to Midsummer last.

Consumption of Smoke.—No apparatus has been attached to the furnaces of this Company for the consumption of smoke. Welsh coal and screenings are used for the fires; the screenings being used in front, the smoke passes over the live Welsh coal and is converted into flame.

Quantity of Water Supplied.—The average quantity of water distributed daily, for the week of seven days, ending the 4th July, was 6,895,368 gallons. The number of tenements now supplied, exclusive of stables, is 25,732. The water is furnished to all parts of the district daily, Sunday excepted, and to some parts twice a day.

Cost of Works.—The total cost of the additional works executed since the passing of the Company's Act of 1852, to the 30th March last, has amounted to 157,399*l.* 14*s.* 7*d.*, making with the previous outlay, a total expenditure of 805,950*l.* 0*s.* 8*d.*

General Remarks.

The buildings and engines of this Company at Hampton are similar to those of the Grand Junction, and of the Southwark and Vauxhall Companies, except that the engines are of somewhat larger dimensions, as described in the return. The air vessel is here of wrought-iron, 5 feet in diameter and 18 feet high. A height of water 30 feet high in the stand pipe is sufficient pressure to command its delivery at Barnes. Working with 4 feet head of water, about six gallons per hour are stated to pass through each square foot of surface of the filter beds. They are cleansed at intervals varying from ten days to seven or eight weeks, according to the state of the river. The river was turbid at the time of the inspection.

The water is conducted across the river to the engines at Hammersmith by the same main in the bed of the river which previously took the supply from the subsiding reservoirs. The direct connection of this main with the subsiding reservoirs still remains. It is stated to be maintained in case of accident to the filter beds, but as the filter beds are arranged in three distinct divisions, this precaution appears to be wholly unnecessary, and it would be more satisfactory that the connection with unfiltered water should be destroyed. The filtered water was bright and pleasant to the taste, very different to water taken from the reservoirs. Even after the subsidence which the water undergoes in passing through the reservoirs, it is by no means fit for domestic use.

At Hammersmith the water is pumped direct into the distributing mains without any stand pipe, the air vessel being similar to that at Hampton.

The covering of the Barrow Hill reservoir appears to have been an economical as well as an efficient work; the cost was about 5000*l.* The arches have a slight covering of cement, but no soil is laid over them, the ventilation through the hollow brickwork of which they are composed being found sufficient to keep the water cool; the temperature of the water in the reservoir has been found to be raised only 3 degrees during summer.

THE LAMBETH WATER COMPANY.

WORKS IN 1850.

Sources of Supply.—The Company's authorised supply, until the passing of the Act 11 Vict. c. 7., was the river Thames at Lambeth. The latter Act enabled the Company to obtain their supply of water from the same river, above the tidal influence, at Thames Ditton.

Reservoirs.—The available capacity of the Company's reservoirs, three in number, was 15,900,000 gallons. Two at Brixton, formed with brick walls and paved bottom, comprised about three acres in extent, and were calculated to contain, when full, 12,150,000 gallons; the third, 1½ acre in extent, having brick walls and earth bottom, was capable of holding 3,750,000 gallons.

Filtration.—The whole of the water supplied was passed through a vertical filtering medium of gravel and sand about 7 feet thick.

Steam Power.—The amount of steam power employed was stated nominally at 252 horses; the engines, five in number, being of the following dimensions:—

1. Engine, cylinder 64⅜ inches diameter; stroke 8 feet.
2. Engine, cylinder 46½ inches diameter; stroke 8⅓ feet.
3. Engine, cylinder 20½ inches diameter; stroke 3 feet.
4. Engine, cylinder 16¼ inches diameter; stroke 3 feet.
5. Engine, cylinder 11 inches diameter; stroke 2⅝ feet.

Mains, Branches, &c.—The length of mains, branch mains, side services, and services for small streets, was about 135 miles, varying in size from 23 inches in diameter to 2 inches.

Quantity of Water Pumped.—The total quantity of water pumped for supplying the district during the year 1849 was 1,123,200,000 gallons. The quantity supplied for all purposes gave an average of 154 gallons per house per diem.

Tenements Supplied. — The number of dwelling-houses supplied amounted to 23,396; and large consumers (from the mains), 147. The highest service afforded by the Company was about 350 feet above high-

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water, and the lowest, 4 and 5 feet *below* high-water mark. The supply was given daily to the district lying below St. Matthew's Church, Brixton, forming nine-tenths of the entire district. The more distant and elevated localities received their supply of water three and four days per week.

Cost of the Works.—The total expenditure on the works amounted to 307,352*l.* 8*s.* 1*d.*

RECENT ALTERATIONS AND ADDITIONS.

Source of Supply.—The river Thames, between Kingston and Thames Ditton, whence the supply has been drawn since January 1852.

Filter Beds and Reservoirs.—The water is let in direct from the river to the filter beds, and after filtration is pumped to the reservoirs at Brixton. There are four double filter beds at Thames Ditton, but they comprise only altogether an area of 32,000 superficial feet, which will be found a very small extent of filtering surface in comparison with that of the other Companies. These filter beds, constructed with brick retaining walls, immediately adjoin the river. The filtering medium is about 6 feet in thickness, and consists of Thames and Harwich sand, and fine and coarse gravel in layers. The two reservoirs at Brixton, comprising an area of 3 acres, have now been covered. They were each originally divided lengthwise by a wall, to effect a circulation of the water, and this arrangement is still retained. The covering consists of brick arches 9 inches thick, springing from walls 1½ brick thick, and 20 feet from centre to centre; these walls have large openings in them, with buttresses between. The Streatham reservoir remains uncovered, it being situated beyond the five miles radius from St. Paul's Cathedral prescribed by the Act for covered reservoirs.

Engine Power.—The aggregate nominal engine power of the Lambeth Water Company is now equal to 680 horses. Two pair of W. Simpson's engines of similar construction, and of excellent and substantial design, have been erected at Kingston. One pair is sufficient for the ordinary duty. The new engines are of the combined high pressure and condensing description. The high pressure cylinders have 28 inches diameter, length of stroke 5 ft. 6½ in. The low pressure cylinders have 46 inches diameter, and 8 feet length of stroke. They are worked from cylindrical boilers with central furnaces and flues. A small engine is also erected here for draining the filter beds when cleansing is required. A pair of small engines at Brixton raise the water thence to the higher reservoir at Streatham. The old engines described in the previous return have been disposed of.

Mains, Branches, &c.—The main from Thames Ditton to the Brixton reservoirs for the supply of the district is 30 inches in diameter, and 10¼ miles in length. With the view to future extensions, three lines of main have been laid at all the crossings; and wherever the main passes through private property sufficient width of land has been purchased for laying three parallel lines. The total length of pipeage now laid is 206 miles; the additional length laid in the district since the previous return being 71 miles. The plan of the Company's mains and district mains, required by the Metropolis Water Act, is complete, having been corrected to June last. It is on a scale of 16 inches to the mile.

Consumption of Smoke.—No apparatus is employed for the consumption of smoke of the furnaces. Welsh coal is used.

Quantity of Water Supplied.—The average supply of water in 1855 was 6,109,000 gallons per diem, and during this summer it has amounted to nearly 7,000,000 gallons. The number of tenements supplied is 28,541. Nine-tenths of the district is supplied daily, and the remainder on the high land in the country districts, four times per week.

Cost of Works.—The total expenditure under the new Acts of 1847 and 1852, to the present time, has amounted to 301,633*l.*, making with the previous outlay a total expenditure of 608,985*l.* 8*s.*

General Remarks.

The whole of the works of this Company at Thames Ditton were executed under the powers obtained in 1847; but as they were merely anticipatory of the General Act of 1852, being precisely of the character that would have been carried out under the provisions of that Act, which require that the sources of supply from the Thames should be above the tidal influence, it has been thought right to include them as new additions.

These works are situated on a strip of land partly embanked from the river to an uniform line. There is sufficient area of land for a considerable extension of the works, which have been laid out on a comprehensive scale, and have been efficiently executed.

The substantial brick buildings consist of engine and boiler houses, chimney in form of a square castellated tower, workshops, offices, extensive coal shed, and a range of baths and other sanitary arrangements for the workmen.

The river was turbid at the time of inspection at Kingston, but the filtered water was bright and pleasant as the samples of the other Companies. When the river is so charged with matter in suspension, a filter bed is said to run freely only for about three days.

The drainage of Thames Ditton formerly discharged into the river above the site of these works. An intercepting sewer, 3 ft. 6 in. by 2 ft. 6 in., in diameter, has been laid down by the Company, extending for about a mile and a half above the intake of their supply of water, and for about half a mile below, for discharge of this drainage. Power has been taken in the Company's Act to carry the sewer as far up as Moulsey for the same purpose.

The pumps are of double action; the water being raised by the upstroke as well as the down, and driven forward direct into the mains. No stand-pipe is employed, but in addition to the ordinary air-vessel, there is an air-chamber formed above the pump-valves, into which air is constantly pumped.

The covering of the two reservoirs at Brixton, comprising an area of about three acres, cost about 13,500*l.* The whole surface of the arches is covered with soil, and laid down in grass.

The accident which occurred here from the fall of some of the arches arose from no deficiency of construction, for the work is of the most solid description, but from the too early removal of the centering. Only four sets of centres were employed by the contractor. The engineer afterwards required that the whole of each line should be put in at one time. One of these reservoirs was completed and at work before the 31st August, 1855. The other is in course of completion.

THE CHELSEA WATER COMPANY.

WORKS IN 1850.

Source of Supply.—The water was procured from the Thames by means of a conduit pipe laid across the bed of the river beyond mid-stream, near the Red-house, Battersea.

Reservoirs and Filter Beds.—The Company had four subsiding reservoirs, comprising together an area of 3½ acres. They were 15 feet deep, constructed with sloping sides and bottoms, paved with bricks on edge laid on concrete. The whole of the water was filtered; the filter beds comprised an area of 90,000 superficial feet, and the filtering medium consisted of gravel, shells, and sand, 8 feet thick. Two open service reservoirs received the filtered water from the Chelsea Works. One in the Green-park comprised an area of 1½ acre, was 10 feet deep, and was constructed with brick walls and paved bottom. One in Hyde-park was ¾-acre in extent, and 7 feet deep, constructed with brick walls and concrete bottom.

Engine Power.—The steam-engines of the Chelsea Company amounted to 310-horse power; they were situated at Chelsea.

Mains and Branches.—The length of the mains and service pipes was about 134 miles; the large mains were 18, 12, and 10 inches in diameter, the auxiliary mains 7 and 6 inches in diameter, and the services 5, 4, and 3 inches.

Quantity of Water Pumped.—The total quantity of water pumped into the mains supplying the district in 1848 was 1,248,115,000 imperial gallons; the average daily quantity per house, including trade and other purposes, was 219 gallons; excluding these purposes, the daily supply per house was 187 gallons; there were from 200,000 to 300,000 gallons delivered per day to large consumers.

Tenements Supplied.—The number of tenements supplied in 1849 was 29,996, and the supply was given daily throughout the district. The highest service afforded by the Company was 157 feet above high-water mark, and the lowest 4 feet above the same level.

Cost of the Works.—The total expenditure upon the works, including an outlay of 35,000*l.* which was being incurred at the time of the return, amounted to the sum of 455,712*l.*

RECENT ALTERATIONS AND ADDITIONS.

Source of Supply.—The river Thames at Seething Wells, near Thames Ditton immediately contiguous to the point whence the Lambeth Company's supply is taken, and about two miles above Teddington Lock. The filtered water was first supplied from this source to about half the Company's district on the 2nd July 1856, and it has now been extended to the remainder.

Reservoirs and Filter Beds.—Two new subsiding reservoirs, with slopes of 1 to 1, lined with brick on edge laid on concrete, have been formed at Seething Wells. They comprise an area of 3 acres, and are each capable of containing 10,000,000 gallons of water. Two filter beds adjoin them, which comprise an area of 2 acres, and are each capable of filtering 10,000,000 gallons in 24 hours, at the rate of 2 gallons per hour per foot. The filtering medium is 8 feet in thickness, and consists of the following layers:—Fine sand, 2 ft. 9 in.; coarse sand, 7 inches; shells, 2 inches; fine gravel, 1 ft. 6 in.; coarse gravel, 3 feet. The several layers are formed undulating, with the view to obtain better drainage and greater facilities of cleansing.

Two covered reservoirs adjoining each other have been constructed on Putney-heath; they are 2½ acres in extent, and hold 20 feet depth of water. These reservoirs command a maximum height of service of 170 feet above Trinity high-water; they have sloping sides, paved with brick on edge, laid on concrete; the covering consists of brick arches, springing from 14-inch walls, of similar construction to that of the Lambeth Company's reservoirs at Brixton. A third (open) reservoir adjoins these, which is formed for a supply of unfiltered water for road and street watering, flushing, &c. It is half an acre in extent. A convenient cottage is in course of erection here for the reservoir keeper.

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Engine Power.—The aggregate nominal engine power of the Chelsea Company is now 700 horse. It is comprised in, first, two pair of W. Simpson's double cylinder or compound engines, similar to those of the Lambeth Company; small cylinders 28 inches diameter, large cylinders 46 inches diameter, and 8 feet stroke; the nominal power of these engines is 650 horses. Secondly, two engines with single cylinders 20 inches diameter, and 3 feet stroke: the nominal power of these engines is 50 horses. The pumps worked by the larger engines are of the united plunger and bucket construction, with buckets 24 inches diameter, plungers 17½ inches diameter, and 7 feet length of stoke; thirteen boilers have been erected for the supply of these engines: the pumps worked by the smaller engines are of the same construction, with buckets 11½ inches diameter, plungers 8 inches diameter, and length of stroke 2 ft. 7 in.: the whole of these engines have been erected at Seething Wells, and it is the Company's intention to pull down and sell the pumping machinery of the old works at Chelsea. Four double cottages have been erected at Seething Wells for the enginemen and workmen of the Company.

Mains, Branches, &c.—The total length of pipeage is now 198½ miles, the additional length laid since the previous return being 6½ miles; two mains have been laid complete from Seething Wells to the Putney Heath reservoirs, one of 30 inches diameter, for filtered water, for the supply of the district, and one of 15 inches diameter for unfiltered water, for the supply of the parks, for street watering, &c. At all crossings and difficult places on the line, a second length of 30-inch main has been laid, and sufficient land has been purchased for laying four 30-inch mains; the mains from Putney-heath to the district consist of two of 24 inches diameter, and one of 12 inches: the plan of the mains and district mains required by the Metropolis Water Act, 1852, is in progress, and it will include all the pipes of the new works recently constructed by the Company. The scale of the plan is 40 inches to the mile.

Quantity of Water Supplied.—The average quantity of water pumped daily in 1855 was 5,323,000 gallons, and during the present summer it has reached 6,914,000 gallons per diem. The number of tenements supplied is now 25,030; the supply is furnished to all parts of the district daily.

Cost of the Works.—The total expenditure upon the Works under the Acts of 1852 has amounted to 472,324*l.*, which sum, added to the previous outlay, makes the total cost of the Chelsea Company's Works 928,036*l.*

General Remarks.

The new works of the Chelsea Company above described are of the most substantial and excellent kind. The buildings are of plain although handsome character; but the engine chimney, in the style of an Italian campanile tower, is more ornate, and forms a striking feature in the landscape. The river wall, built to an uniform line of considerable length, is constructed of concrete, and forms a handsome terrace.

The Company have acquired a sufficient area of land at Seething Wells for a very great extension of their works, and the buildings have been so designed as to admit of their being doubled or ultimately quadrupled on an uniform plan, when the necessity for such increased arrangements may arise.

The mains from the new reservoirs at Putney-heath to the district are carried over the river Thames by a bridge of wrought iron plate girders, resting on iron columns upon screw piles; the bridge has nine openings, the centre span being 90 feet, and 20 feet in clear height above Trinity high-water; this work occupied only 15 months in construction.

It has been before stated, that the Chelsea Water Company were allowed by the Metropolis Water Act, 1852, until the end of August of the present year for the alteration of their source of supply, but the state of the river within tidal influence, already bad, has become latterly so seriously worse, that the Company were anxious to effect the alterations with all possible speed, and great credit is due for the energetic manner in which the works have been carried out and the change accomplished before the expiration of the time allowed. The works at Chelsea are now altogether disused, but the connections have not yet been severed.

THE NEW RIVER WATER COMPANY.

Works in 1850.

Sources of Supply.—Chadwell spring, near Ware, in Hertfordshire; the river Lea, Spitalbrook; small springs taken into the river in its course; also the water-shed of the Northall district, and four deep wells sunk into the chalk in Middlesex and Hertfordshire. The quantity obtained from these sources was as follows:—

From Chadwell springs	500	cubic feet	per minute
,, River Lea	1340	,,	,,
,, Amwell well	196	,,	,,
,, Amwell-hill well	285	,,	,,
,, Cheshunt well	50	,,	,,
,, Hampstead-road well	70	,,	,,
Total	2441	cubic feet	per minute

Reservoirs.—There were six reservoirs, situate at the following places: At Cheshunt two reservoirs, area 18 acres 2 roods; at Stoke Newington two reservoirs, area 42 acres 2 roods; at the New River Head one reservoir, area 5 acres; and in the Hampstead-road one reservoir, about 200 feet in diameter, built with brick sides.

Filtration.—No description of filter was used; the water generally had a period of seven days for subsidence in the store reservoirs. The Company stated further that, "In the reservoirs at Cheshunt where the water is taken from the water-shed of the district north of the same, it was generally retained *a month*, and in the New River where the current is gentle, as also at five enlarged portions of the same, there was much time for the deposit of any alluvial matter which it may contain."

Engine Power.—The effective engine power possessed by the Company amounted to 720 horses; the amount of steam-power exerted during the summer was equal to about 360 horses working sixteen hours each day; in the winter it may be taken at 260. The *nominal* engine power of the Company was 442 horses.

Mains, Branches, &c.—The length of pipeage was not given in the return of this Company, the details having never been kept.

Quantity of Water Pumped.—The quantity of water delivered in the year 1849 was 18,000,000 gallons per day during the summer drought. In the previous year 918,517 gallons per day (Sundays excepted) were delivered to large consumers. The quantity supplied for all purposes amounted to about 170 gallons per house per day.

Tenements Supplied.—The total number of tenements supplied was 83,206, and 444 large consumers; about 230 houses had a constant supply. The highest service afforded by the Company, was 230 feet above high-water mark, and the lowest 5 feet above the same datum. In the principal and more populated part of the Company's district, the supply was furnished daily; in the country districts, north of the Regent's Canal, it was given only four days in the week.

Cost of the Works.—The total expenditure upon the works to the end of the year 1848, was 1,421,717*l.*

Recent Alterations and Additions.

Source of Supply.—The source of supply remains unaltered; but considerable change has been effected in the course of the New River. Many of the bends have been cut off and straightened, and the length of the channel has been thereby greatly reduced. An Act has been obtained for the diversion of the Hertford sewerage from above the Company's intake from the river Lea; but nothing has yet been done towards carrying out this improvement.

Reservoirs and Filter Beds.—The reservoirs at Stoke Newington and Cheshunt are still used as subsiding reservoirs; those at Stoke Newington have been cleaned out and deepened, which has added about 40 per cent. to their capacity. The old reservoir at the New River Head receives the surplus water of the river which passes the Stoke Newington works. The reservoir near the Brecknock Arms is now intended only for the supply of the New Cattle Market; and that at the Hampstead-road for the supply only of the contiguous baths and washhouses.

Filter beds have been constructed, both at Stoke Newington and the New River head; those at Stoke Newington, five in number, cover an area of 6½ acres, and space is reserved for two more; those at the New River Head are three in number, covering an area of 2½ acres. The supply of filtered water to part of the district was commenced at Christmas 1855, and was subsequently extended over the whole district, with few exceptions, for the completion of which further pipeage is required, and will speedily be supplied. The filtering medium is 5 feet in thickness, two of which consist of sand, and the rest of gravel in layers, increasing in coarseness towards the bottom. The Claremont-square reservoir, which receives the filtered water from the New River Head, has been covered over in accordance with the provisions of the Metropolis Water Act, 1852; the covering consists of brick arches springing from cross arches on brick piers. This reservoir has an area of 31,000 square feet, and is capable of holding 3½ million gallons.

Two new covered service reservoirs have been constructed at the top of York-road, King's-cross, 220 feet above high-water mark; the covering of these is of the same description as of that at Claremont-square; the area of each is 56,784 feet. With 22 feet depth of water they are capable of containing 7½ million gallons. They receive the filtered water direct from the Stoke Newington works. The arching of these reservoirs, as well as of that at Claremont-square, is covered with soil. Another covered reservoir for filtered water is situated at Stoke Newington, of different construction to the others; the water, 22 feet in depth, is wholly below the surface of the ground, and the reservoir is enclosed by brick walls above ground, spanned with an iron roof covered with slates. Its area is 19,440 superficial feet, and it is capable of holding 1¾ million gallons.

Engine Power.—Six new engines have been erected at Stoke Newington of 1000 nominal horse-power; two pairs are by W. Simpson, and are copies of those at the Lambeth and Chelsea Works, on the combined high-pressure and condensing principle; the high-pressure cylinders are 28 feet in diameter, the length of stroke being 6 ft. 6½ in.; the low-pressure cylinders are 36 inches in diameter, and the length of

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stroke 8 feet. Each of these engines has one pump 27 inches in diameter, 6 ft. 11 in. stroke. One pair of engines has been supplied by Boulton and Watt; the cylinders are 60 inches in diameter, the length of stroke is 8 feet. Each engine works two pumps, one of 43$\frac{1}{11}$ inches diameter, and 4 ft. 9 in. stroke, the other of 31$\frac{1}{2}$ inches diameter, and 7 feet length of stroke. There are 18 boilers for the supply of the 6 engines.

Consumption of Smoke.—No apparatus has been attached to the furnaces for the consumption of smoke; the best Resolven Welsh coal only is used.

Mains, Branches, &c.—The entire length of pipeage possessed by this Company is not exactly known. No quantity was named in the return of 1850; but it is stated to be now somewhat between 400 and 500 miles. A plan of the mains and district mains, as required by the Metropolis Water Act, has been laid down on the Ordnance engraved sheets, 5 feet to the mile.

Quantity of Water Pumped.—The daily quantity of water now pumped for distribution is 25 million gallons. The number of tenements supplied is 95,083. The supply is given daily (Sundays excepted) to all parts of the district; and, where necessary, in the poorer localities, in consequence of insufficient cisternage, on Sundays also.

Cost of the Works.—The total sum expended since the passing of the Company's Act, 1852, for new works and extensions, inclusive of purchase of lands, &c. for further operations was 566,084*l.* to the end of the year 1855, making with the previous outlay a total expenditure of 1,987,801*l.*

General Remarks.

It will be observed by the above statement that the new works of the New River Company are of a most extensive description. The New River Head is not a very desirable locality for filter beds, but otherwise the works have been carried out in a liberal spirit, and no expense has been spared that could render them substantial and efficient.

The engine buildings at Stoke Newington partake of the character of a Scotch castle, and form a prominent feature in the landscape for a considerable distance.

The large subsiding reservoirs at the same place were formerly equal to 10 days' supply; but, owing to the rapidly increased demand for water, are now only capable of 5 days' storage. When lately cleared out and deepened, only 10 inches of deposit were said to have been found, although the reservoirs have been in use for 20 years. The heavier particles in suspension would, no doubt, have been deposited along the course of the New River and in the other reservoirs before reaching those of Newington; but it would appear to be impracticable to separate the finer matter entirely by rest. As stated in the return, no means of filtration were employed by this Company previous to the Act of 1852.

The filtering medium alone has cost the Company 35,000*l.*

The cost of covering the Claremont-square reservoir was 21,000*l.*; the expense was much increased by the necessity of supplying the tenants from the reservoir at the same time that the works were in progress, which required the construction of cross dams.

The pipe from the tank at the New River Head, which formerly supplied the unfiltered water to the district, it is proposed to retain for the supply of unfiltered water in the same way during periods of frost. The Company's engineer considers that means of supply, independent of the filter beds, should be maintained, because 5 or 7 inches of snow may, in heavy falls, pass through the water on to the surface of the sand, and obstruct the filtering action. From all experience on this subject there is reason to believe that there would be no possible danger of this if the ordinary depth of water is kept on the filter beds, while it would certainly be more satisfactory that the means of supplying unfiltered water to the district should be removed.

The old engines at the subsiding reservoirs at Newington, for the supply of the Highgate district, will remain as they were, as well as that erected at Highgate for the higher lift.

The extensive works in progress in deepening and improving the channel of the New River, and in cutting off many of its windings, will have the effect of shortening its length very materially.

The Chadwell spring, the original source of supply of the New River Company, yields about 500 cubic feet per minute; 274 cubic feet are derived from the wells at Great Amwell, and some small additions are obtained from other wells and from tributaries to the New River, but the main source of the Company's supply is now the river Lea, from which 1840 cubic feet of water per minute are taken, with power reserved to extend the quantity to 2500 feet. Under these circumstances it does seem important that the drainage of Hertford, which discharges immediately above this source of supply, should be diverted from it, and it is to be hoped that the powers obtained by the Company to effect this object will soon be put in operation.

(To be continued.)

There is a talk in Paris of a project for opening a monster café on the Boulevard St. Denis, to contain 86 saloons, each to have a decoration typical of one of the departments of France.

ON BOILER EXPLOSIONS.

By MATTHIAS DUNN, Government Mine Inspector.

[*Paper read before the Northern Institute of Mining Engineers.*]

THE explosion of boilers has now become as exciting a subject as the explosions of collieries, and in many cases as difficult to account for, but having been engaged in examining witnesses upon the recent cases which have occurred at Kibblesworth and Walker, I have collected together some of the most important parts of the evidence, and have also consulted certain scientific authorities as to the effects of steam and water in connection with hot iron, as well as the ordinary apparatus of boilers in respect to the steam and water communications, &c., with a view of inviting discussion, and of bringing forward the practical talent with which the Northern Institute abounds, to endeavour to devise some means of checking this growing evil.

I have endeavoured to ascertain how far the danger of explosion is increased by the prevailing custom of having four, five, or six boilers all intercommunicated by the same feed and steam pipes, but practical persons seem to think that there is nothing objectionable in this, inasmuch as each boiler has its own branch pipe, with suitable stop valves. It is understood in practice that when one boiler is feeding, all the other feed valves should be shut, because, if two valves are open at the same time, the strength of steam in one boiler may force the water out of it into one or other of its neighbours, and so cause the boiler to become suddenly dangerous for want of water.

The quantity of water in high-pressure boilers continues to be ascertained by means of the float or piece of stone suspended or attached to a wire led through the boiler top, and poised by means of a balance-wheel with a weight to denote the rising or falling of the water. This apparatus has been recently improved upon by sundry devices for producing a whistle, or alarum, when the water falls below a certain point.

Amongst the most recent of these applications is Dirck's Patent Anti-explosive Apparatus. He assumes that boiler explosions, for the most part, originate in over-heating, but not necessarily from a deficiency of water, sometimes from the sticking or over-weighting of the safety-valve, and he has, therefore, invented a means for cooling down the water by the introduction of cold water, to flow through coils of pipes immersed in the water, and discharging by a pipe leading outside. The introduction of the said cold water is to be induced by "*the over-heating of the boiler*," and its contents acting upon a fusible alloy, which, when melted, opens a valve or water-cock, connected with a cistern above, which allows the water to pass into and through the refrigeratory tubing within the water of the boiler, and discharging within sight of the fireman. The patentee says: "Combinations of tin, lead, and bismuth, in different proportions, melt at known temperatures, thus in parts of 3, 5, and 8, the alloy melts at 212°, while in parts of 2, 3, and 2, the alloy melts at 270°. Then, as we know the temperatures of given pressures, we can accommodate the alloy to melt at very near the required pressure, which I call the '*danger heat*,' for 15 lb. pressure is 251°, 30 lb. is 270°, and 60 lb. pressure is 309°. It is not meant to substitute the usual gauges and safety-valves, but to call attention."

Johnston's Improved Self-Acting Alarm is founded upon the assumption that almost all boiler explosions arise from a deficiency of water. He, therefore, proposes to furnish each boiler with an apparatus, so that when the water falls below a certain level, the steam acting upon the instrument, produces a whistle. The float consists of a large "*hollow metal ball*," made sufficiently heavy that in the falling of the water, it opens the orifice and whistles.

A third invention for which Mr. Hall, of London, has taken out a patent, is founded upon the following assumption, viz.,—"That explosions are not occasioned by a constant pressure of steam allowed steadily to increase until its tension is greater than the strength of the boiler, but, by permitting the water to become so low as to expose the plates to a high temperature, they surcharge the steam with caloric far exceeding that due to its pressure, and in injecting an additional supply of water into this heated steam, which acts like a blow. It is also known that the water level may be raised even by opening the safety-valve, which, instead of tending to safety, may thus become the cause of producing the explosion, which opinion is strengthened by the fact that the greater number of accidents occur

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immediately after starting the engine." He therefore proposes a "'*water blow off valve*,' to operate when the surface of the water has fallen to a dangerous extent; the said valve might be made self-acting, either by *a float, or what is preferable*, a fusible metal cup, enclosing a bolt head to which the valve is attached at the other end, and retaining it in its seat. The valve communicating with the water, and kept in position by a rod terminating with a small head, which is held in the cup by soft fusible metal, and the cup riveted to the crown of the tube or boiler. If the tube or furnace be unduly heated, the rod would be released, and the valve permitted to open and discharge the water from the boiler, the pipe connected with this apparatus terminating near the bottom of the boiler, the water to be forced up by pressure of steam. The valve being inverted and kept in its place by a small spiral spring, allowing the float to be at liberty until the water falls from it, when it opens the valve and releases the water. The cup that is riveted into the tube is not lead, but another metal, the quickest conductor of heat and most fusible that we can find for the purpose, run into it upon the head of the bolt; it is to do away with the lead plug, for we find that the action of the fire on one side and water on the other, so act upon the lead as to oxidise it, so that it almost becomes tin. We have tried several of the lead plugs which have been in some time, and instead of melting at 415° or 420°, they do not melt till nearly 600°, and sometimes as high as 950°, and it is to get over this that we adopt the cup. An experiment with the cup standing 2½ inches above the tube, melted the fusible metal whilst the water was still on the tube."

Mr. Hall's ideas are still further explained in a subsequent letter of November, 1855, viz: "These considerations naturally and inevitably lead to the conclusion that safety is alone to be attained by opening a water-blow-off-valve when the surface has fallen to a perilous extent for the purpose of first discharging the water, which is the more dangerous agent, from the boiler, and then the steam operating, in fact, as a safety-valve placed in a more useful and less objectionable position than the present steam-valve, situated on the dome. This valve might be rendered self-acting by a float, or what, perhaps, would be preferable, a fusible metal cup, enclosing a button, by which the valve would be retained in its seat, unless subjected to the temperature at which it was designed to melt. A valve communicates with the water, and is kept in position by a rod which serves for its stem, and terminates with a button cemented with fusible metal into a copper cup riveted to the crown of the boiler. If the furnace should be suddenly heated, the button would be relieved, and the valve permitted to open and discharge the water and steam from the boiler. The boiler might be injured, and perhaps the flues destroyed by the fire, but it could not be exploded."

A fourth steam and water gauge, the patent of Mr. Sydney Smith, Hyson Green Works, Nottingham, is highly spoken of and extensively used. The following are the remarks by the patentee:—

Steam Indicator.—In construction it is neat, simple, durable, instant in action, and shows every variation of pressure with the most exact and delicate precision, thereby preventing the frequent and disastrous boiler explosions resulting from ignorance as to the actual pressure of steam in the boiler. For marine boilers the patent steam indicators are well adapted, as they are not affected by the rolling of the vessel or heat of the engine-room, and can be placed in any suitable position, either near the boilers, in the captain's cabin, or alongside the compass.

Magnetic Water Gauge.—In consequence of the frequent bursting of the common glass gauge, and the trouble and expense of renewal, a gauge that is not liable to these casualties is much wanted. The magnetic gauge is neat in appearance and simple in construction and action, and is not liable to derangement; it is placed on the top of the boiler, near the front; a copper ball float, which rises or falls with the water, is attached to a magnet behind the dial of the gauge, by means of a brass rod, and causes the moveable hand to indicate the height of water with the most exact precision.

Cylinder Water Gauge.—In cases where the upright magnetic water gauge cannot be applied, the cylinder gauge is recommended. It is placed in *front* of the boiler, and in principle is similar to the other, except that instead of an upright scale, the magnet attracts a needle round the face of a graduated dial plate, by turning on its axis, worked by a copper ball float.

Extracts from Coroners' Inquests after sundry Boiler Explosions.

I.—*Boiler Explosion at Kibblesworth Colliery, Durham.*

An explosion occurred at this colliery on the 19th September, 1855, by which one man was killed, and the circumstances under which it happened seemed to afford a good opportunity of scrutinising the causes which had preceded this calamity. The establishment consisted of five cylindrical boilers, each 30 feet by 6 feet, loaded on the safety-valve, as they expected, at 35 lb. per inch. The boilers were all intercommon in regard to the steam and feed pipes, having the necessary stop-valves also well fitted up with float apparatus and safety-valves, and managed by steady men. The explosion happened, too, at 8 a.m. The night and day man had changed at 6 a.m., and reported that all was in the most satisfactory state at that time. After a long investigation before Mr. Hudson, the Deputy Coroner, a verdict was brought in of "Accidental Death," and in order to put people on their guard against such an oversight as was supposed to have brought about this mishap, I published pretty extensively the following exposition,

"By this explosion an unfortunate young man lost his life, for the boiler was rent into three pieces and driven 150 yards from the place. It very seldom happens that a clear elucidation of the immediate cause of these explosions is arrived at, but in this case it was discovered that *the feed valves belonging to two of the boilers* had been open at the same time, and as proof was given that two hours previous to the explosion all the five boilers were in a perfect working state, no ordinary boiling could have diminished the water to such a dangerous extent. There was, therefore, no room to doubt that, in consequence of the two valves being open, the water in the boiler which exploded had been *primed or driven* into the neighbouring boiler, and in consequence the former had become heated up to redness, whilst it was also obvious that the engineer was at the time in the act of turning on water, which is a very common and natural course to take. I have, therefore, deduced from these examinations some instructions which I will endeavour to make public, as to the course which ought to be taken when a boiler is discovered to be in a dangerous state for want of water:

"1st.—Not to attempt to pull out the fire, because, whilst that is doing, the heat will be more intense, but to set open the fire door, and deaden the fire with green coals; if damp, so much the better.

"2nd.—To close the pipe communications with the other boiler; but leave the damper open.

"3rd.—To set open the discharge steam valves; and not to introduce any water until all is cooled down.

"If the proprietors of collieries and manufactories would cause these simple rules to be circulated among their operatives, it would tend to warn them what to do in so critical a moment, instead of being left to the natural but dangerous expedient of introducing water."

Since publishing the above remarks, I have reason to believe that the opening of the steam-valve, under such a dangerous state of things, would not be the most prudent course, because the sudden rush of the steam might have a tendency to raise the water of the boiler up against the heated plate, and also to convey to the steam itself (perhaps liquified by extreme heat) so violent a motion, as to produce explosion. I therefore conclude, that beyond insulating the boiler and cooling it down, the less violent change made the better.

II.—*Walker Works Boiler Explosion.*

W. Livingstone's Evidence (*Engineer*).—This explosion happened on the morning of October 8, 1855, whereby one was killed and several others greviously wounded; the boiler was blown into four pieces and carried to a considerable distance from the place. The boiler in question was made of ⅜-inch plate (one of six all inter-communicated), was 25 long, and 6 ft. 8 in. diameter, and loaded with from 35 lb. to 40 lb per inch. The boiler was pretty old, but had undergone important repairs, so that it was adequately strong for more than the intended pressure. Each boiler had two safety valves. They had also Smith's indicator attached to the floats to show the quantity of water contained in the boiler. The safety valves were taken out and examined once a fortnight, and the feed-pipes were fitted with a flap at the bottom, opening upwards to guard against the water being primed up the pipe into the neighbouring boilers. At the time of the explosion the engine had been at work upwards of four hours. The water which fed the boilers was heated, and the boilers were cleaned every fortnight. It was in evidence that half an hour before the explosion the engineman, in answer to a question, said that "*there was rather too much*," and in consequence had shut off the supply to send it to the other boilers,

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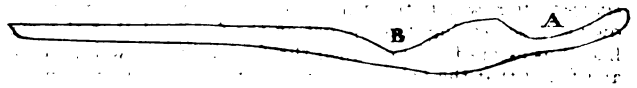
which was corroborated by the fact of the valves being found shut at the time of the explosion. Two of the boilers were closely connected together, and a priming might have taken place, but not likely. He believed there was no want of water at the time. He was at a loss to know why the boiler had been thrown so far from its seat except that there had been a deficiency of water. The safety-valves were were found quite free and in good order. One continuous feed-pipe supplied six boilers, each boiler having a branch pipe and valve. If the flaps got out of order the boilers might prime into each other; the flap is placed within four or six inches of the bottom of the boiler. One main steam-pipe supplied all the boilers, each boiler having also a branch pipe and valve. The boilers might prime through the steam-pipes, but he never knew it to be the case. If he found the boiler in a dangerous state he would dampen the fire and draw it, although this, for a time, would increase the intensity of the heat. He would also lift the safety-valve quick as possible; these valves were four inches in diameter, but only three inches in clear space. They had no lead plugs in the boilers; if such had been the case they would have melted out, and have given warning of what was happening. He had seen the lead plug often in locomotive-boilers, and thought it might be used in other boilers as well. Had two floats on each boiler. The flap in the boiler feed-pipe was between five and six inches from the bottom, but in some others not more than three or four inches. The flaps were never obstructed in their action by any sediment. It is equally safe to work six boilers together with one pipe as half that number. He had seen lead plugs, but thought the boilers at Walker safe enough without them. He never saw lead plugs used in high-pressure boilers, but had seen them in locomotive engines. The lead plug would melt and extinguish the fire by the rush of water and steam. Yet he could not perceive much advantage in using them.

W. Short.—Was boiler smith, and repaired the boilers. About three years ago the boiler underwent a thorough repair; new plates were put on. Was quite capable of bearing a pressure of 50 lb. per square inch. Thought the boiler could not have exploded if there had been a sufficiency of water in it, even suppose the plates had become heated. After examining the boiler he had come to the conclusion that the boiler had been red hot. The plates had a red appearance as if overheated by fire. He had seen lead plugs used in cylinder boilers such as this. If a lead plug had been placed near the bottom it would have melted, and have warned the men of danger. He considered it would be better to adopt the lead plugs. It was the bottom that was rent asunder, and both ends were blown out. It was not from the intensity of steam, but the want of water.

G. Dove, Engineer of the Works.—If the fire of one boiler was kept up while the fire of the other boiler was being withdrawn, it would have the effect of causing the water to flow through the feed-pipe into the boiler which had an insufficient supply of water, in case there was no stop-valve. The boiler plates would become red hot under a want of water, the steam would then become increased in temperature, and if mixed with water was sure to cause an explosion. He thought no gas was generated in the boiler. When water was admitted into a boiler heated up to 350° or 400° the water would assume a spheroidal shape, would reduce the temperature, and cause an explosion. Had no doubt but that the plates of the boiler had been heated towards red heat, after which, an explosion might occur at any moment. He was of opinion that had been the case with this boiler. There was a steam indicator for the set of boilers, which showed the pressure. The indicator was Sydney Smith's patent, and was considered a satisfactory check. He thought the boiler had become dangerous from priming, but not by the feed-pipe, because of the application of the flap. He thought it had primed through the steam pipe. Independent of the flaps, they have also valves to each boiler to regulate the quantity of water admitted into them. The valves screwed down, and, in case the bottom flap got out of order, the water could be shut off by these valves, and they acted as a check. He would not recommend the *adoption of lead plugs for oblong boilers* without a tube; they might be advantageous for tubular boilers or a boiler with a fire-flue. His reasons were, first, they were out of sight, and secondly, that they would not melt under 594°. There were other metals which might be used with the lead, such as tin and bismuth, which would regulate the melting point to any named degree, but they would not amalgamate and form the plug to be relied upon.

T. Bell, one of the Proprietors, was of opinion that a boiler excessively heated would produce hydrogen gas, provided there was no great pressure of steam in the boiler, because the pressure of steam would split open the boiler before the iron became sufficiently heated to generate the gas. But if there was a low pressure in the boiler, and hydrogen gas did form, it could not explode, owing to the absence of atmospheric air. Water heated into temperature did not produce oxygen and hydrogen gas. If heated, in contact with iron, hydrogen gas alone was generated. In illustration of the principle of heat tending to throw water into a spheroidal shape, an experiment was shown by heating a thin piece of iron *red hot* at the point A,



and B being kept at a lower temperature, when water was put into the cavity A it did not fly away in steam, but danced about in a globe like quicksilver; but upon moving down to the lower temperature of B it immediately exploded into steam. Hence it is inferred that it is not *red heat* which causes the explosion, but some intermediate temperature.

Verdict "Accidental Death."

At the conclusion of the inquest I read the following paper:

"I have thought proper to lay before the jury assembled at Walker, a few extracts relative to the power of steam, under various circumstances, as bearing upon the inquiry now before the coroner and jury, which may probably serve to lead to the consideration of circumstances by scientific persons; but, after duly considering these and other similar circumstances, I have come to the conclusion that the explosion has originated (from whatever circumstance) in the proper quantity of water in the boiler having been wanting. Such want of water might take place from neglect of the person in charge, or it might take place from the priming of one boiler into the other, up the steam or feed-pipes, by which means the boilers were intercommunicated. The boilers would appear to have been well guarded against such an incident, each boiler having duplicate safety and feed valves,—the latter being furnished with flaps, within the boiler, for the prevention of the priming. Notwithstanding these precautions the boiler seams to have undergone undue heat; and although there is no evidence to show that any new feed had been recently admitted, yet I conceive that it is very possible that the agitation of the steam might throw the water within the boiler upon the plates, already so hot as to occasion an instantaneous undue expansion of steam, and so produce the explosion. I am, therefore, against the opinion that hydrogen gas has occasioned the catastrophe; because it will not explode at an ordinary red heat, and it could not communicate with the boiler fires or with atmospheric air.

"With respect to the prevention of such accidents, and under the impression that they almost always originate from want of water (unless the safety-valve either goes wrong or is over-weighted), I am greatly of opinion that the revival of an old practice would be advantageous, viz., to adopt a plug of lead or some alloy which would melt or consume at a temperature between 350 degrees and red heat—as explained by experiment—such plug to be placed in a tube boiler, at the upper part of the tube; and in a common cylindrical boiler half-way between the surface of the water and the boiler bottom. The said plug once consumed, the steam and water would rush out and recall immediate attention to the boiler, which must necessarily then be left to cool down, during which the steam valves should be gradually opened. It would be quite proper, whilst the boiler was being cleaned, to punch out the said plug and substitute a new one, to avoid the objection as to oxidation. The advantage of this over many other devices is its extreme simplicity and freedom from friction or complicity. At any rate, I trust that these remarks will cause investigation and decision amongst practical engineers, so as to diminish these appalling mischiefs. It is undoubtedly an excellent precaution to adopt a flap, or horse-foot valve, at the foot of the feed-pipe, to prevent priming up that pipe.

"P.S.—I add to the above report some experiments by Mr. Horsley, engineer, Seghill, made at my request, to show the rate of steam diminution under different circumstances, the boiler being 27½ feet in length, 6 feet diameter, and the safety-valve having an area of 3 inches."

Steam Indicator 25 lb.	At end of 6 min.	End of 10 min.	End of 15 min.	End of 20 min.
Exp.	lb.	lb.	lb.	lb.
1. Fire door open	23½	20½	18	16
2. Fire damped	21½	18½	16	14
3. Fire pulled out	22½	19	16	13½

III.—*Consett Boiler Explosion.*

An inquest was held on the 14th November 1855, from which I give a few extracts from the published evidence, as it seems to lead to a somewhat different conclusion to the two former ones.

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The boiler was split into two parts, one part flew ninety-one and the other ninety-six yards from the spot.

T. Maddison, Breakman.—There are ten boilers, eight of which are supplied by the same steam-pipe, and the whole ten by the same feed-pipe. They are all fed with cold water.

Mr. Godley, Engineer of the Works.—The water is regulated by one float to each boiler. The person in charge could see the indicator when the water was low. The wire connected with the indicator is oiled every morning, and I never knew it not to act; but if it did stand the indicator would cease to act. I think there had not been sufficient water in the boiler which exploded. I think that some time before the explosion the boiler had been *sludged*, after which the valve had not been sufficiently closed owing to something having got on the face, and that the water had thus escaped. I examined the feed-valves as well as I could and found that the valve belonging to that boiler was open about a quarter of an inch. From the way we feed our boilers they cannot prime over. I found that immediately above the fire-bridge the plates had the appearance of having been red hot, and the plate was torn away. Thickness of plate, three-eighths of an inch. Boiler was perfectly sound, and the water is kept about a foot above the flue, which leaves a space of 2 feet to 2 ft. 2 in. for the generation of steam. I conclude that at the time of the explosion the deceased had found the boiler was short of water, and was turning the feed-pipe. The boilers are supplied with hot water. If I saw a boiler ready to explode in consequence of a want of water, I would dampen the fire, open the fire-doors, and by no means draw out the fire. I would also put the damper down. Drawing out the fire would increase the heat. I would not put the feed on.

S. Elliott.—I think that between the time when I examined the boiler to the time of the explosion, the water could not have sufficiently diminished by heating to cause the explosion.

M. Gardner, Boiler Inspector.—I had examined the boiler which exploded a week before the explosion, and concluded it was a safe boiler. I think the boiler exploded from a want of water; because it would not burst at the low pressure of 31 lb. per inch, which is the pressure at which we work them; we never worked any of our boilers at a greater pressure than 40 lb. I examined the boiler after the explosion and found no flaw or thin place, or any appearance of the plates having given way. The side plates had the appearance of having been hot—the plates had a blue colour.

Verdict, "Accidental Death."

I will now submit a few extracts, from various authorities, touching the nature of steam, air, and metals, which are more or less involved in the question of the explosion of boilers, viz.;—

The expansion of steam at 212° in comparison with water, is stated at 1800 to 1. The density of water in proportion to air is 832 to 1, and 212° is the boiling point of water.

If common steam be enclosed in a vessel and exposed to a pressure greater than two atmospheres, it will be wholly condensed into water, provided no elevation of the temperature be allowed ('Young's Philosophy'), being the force of cohesion by means of pressure. And air compressed to half its dimensions has its temperature raised about 50° of Fah.; $\frac{1}{150}$th part compressed will raise it a degree.

The elasticity of aeriform fluids is increased about $\frac{1}{480}$th part for every degree of heat, therefore, if the heat be raised to more than 5000° the force of each grain of water converted into steam will only be increased *tenfold*.

Steam at 212° is just equal to the pressure of the atmosphere, but by increasing the degrees of heat the following results occur:

	lbs. per square inches.	Temperature Fahrenheit.	Equal inches of Mercury.
Pressure predominating over the atmosphere acting on the safety-valve.	2½	220	—
	10	241	20·6
	15	252	30·9
	20	261	41·2
	30	276	61·8
	35	283	—
	40	289	82·4
	50	300	—

So that by a small addition of temperature an expansive power may be given to from 40 to 400 times and upwards its bulk or any other proportion.

When water is heated up to 212°, the vapour from it resists compression and makes an effort to expand with a force exceeding that of gunpowder, and this effect is continued with *diminished intensity* as the bulk of the steam increases, till it has arrived at 1800 times the bulk of the water that produced it, when it becomes entirely inert, and has no more tendency to burst a vessel than if it were filled with common air; the pressure of the air and the tendency of the steam to further expansion being an exact balance to each other.

A cubic inch of water will produce a cubic foot (1728 inches) of steam.

Latent heat of steam at the common pressure of the atmosphere is found to be 1000°, the sensible or thermometric heat being 212 — 32 (freezing point) = 180°, or 1000 + 180 = 1180°.

Quantity of caloric which heats water 1°, heats mercury 3·16; specific caloric of water 1°, mercury 0·31.

Water is 914 times as heavy as air at the surface of the earth. Its greatest density is 42·5, and if heated above or below that point it undergoes expansion in both cases. Thus at 32° and 53° are the same expansion, same at 80° as at 5°.—(Dalton).

Expansion of water by heat at—

42·5 (Greatest Density)	1·
102	1·00672
122	1·01116
162	1·02245
202	1·03634
212 (Boiling Point)	1·04012

The expansion of air is eight times greater than water, and water forty-five times greater than iron, the temperatures of each substance being supposed raised from 32° to 212°. The more bodies are heated, the less they weigh.

Hydrogen gas is produced by water in contact with iron heated to ignition, but will not explode at red heat in itself. It is not explosive without a large proportion of oxygen, the most explosive mixture being 2 of hydrogen and 1 of oxygen.

Hydrogen is the lightest of all substances except light and caloric, and when pure it is nearly thirteen times lighter than common air. Under heat the oxygen is absorbed by the iron, leaving the hydrogen inexplosive, *which seems to set at rest a common opinion that explosions sometimes take place from the gas which is formed within the boiler.* Heat is capable of producing a galvanic current, the intensity of which is proportional to that of the producing agent.—(Young).

One hundred inches of hydrogen do not weigh three grains, air thirty-one grains. Hydrogen gas is separated by passing steam through a red-hot iron tube.

Hydrogen generally contains half its weight of water.

Iron contains a capacity of $\frac{1}{8}$th that of water, for heat;—lead, $\frac{1}{14}$th; silver, $\frac{1}{17}$th; mercury, $\frac{1}{30}$th. Copper contains nearly the same quantity of heat in a given bulk as water, but lead and glass about one-half only.

Cohesive strength of iron at different temperatures:—

32° to 80°	56·00	This Table exhibits a singular discrepancy in the increasing and diminishing ratio which is not accounted for.
570°	66·50	
720°	55·00	
1050°	32·00	
3000° fluid (query)		

Boiler plate is found to increase in tenacity till it reaches 550°, after which it diminishes.

The lowest temperature which gives discoloration to iron (a straw colour) is about 430°; and the lowest temperature to effect the repulsion of water has been found to be as low as 350°, whilst the water in the boiler may be only 250°.—(Dove).

Rates of expansion—

Iron and Steel	3	Copper	4½
Brass	5	Tin	6
Lead	7	Bismuth	—

Melting heat of various metals (Ferguson):—

Cast iron	—
Pig iron fuses	1500°
Steel red hot	1077
Lead melts before ignition	594
Tin ditto	442
Brass	3807
Bismuth melts	476
Iron red hot in daylight	1207
Copper melts	4537
Hot air for furnace	612
Iron when ignited becomes malleable, but requires for its fusion 158° of Wedgewood.	
Mercury boils at	600

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A writer in the *Gateshead Observer* (Oct. 1855), says—"No gas will ignite at red-hot iron, it must be a white flame before hydrogen ignites.

"Steam may become so pressed as to be equal to iron, and, in consequence, the boiler lifts, and the iron gives way.

"One inch of water will expand to 1728 inches of steam. A boiler heated almost to red heat, and water admitted, the instant the water touches the red-hot iron and made 1728 times its own bulk, becomes more solid than iron. The stronger the boiler the greater must be the explosion.

"Gunpowder is 1000 times denser than the atmosphere. If 1000 inches of atmosphere were compressed into 1 inch, it would be the same strength as an inch of gunpowder. Steam is half the gravity or weight of the atmosphere. If 1728 inches of steam is formed from 1 inch of water, it would be nearly twice the strength of gunpowder. Not one in twenty knows how to find the pressure of the safety-valve."

Conclusion.

From the before-mentioned facts and extracts I deduce the following safeguards for the prevention of boiler explosions.

1.—It would appear that tube boilers are more liable to accidents from overheating than ordinary boilers, owing to the small quantity of water above the tube, whilst the most intense heating takes place when short of water, and practice shows that little or no advantage is derived from the application of a tube.

2.—Every boiler safety-valve should be duplicated by one upon the connecting steam-pipe, or an indicator, that upon the steam-pipe being equal in area to all the other safety-valves.

3.—As very much depends upon the well working of the float, it should either be duplicated or a check apparatus applied upon some other plan.

4.—The bottom of each feed-pipe should be furnished with a flap or horse-foot valve, to guard against priming.

5.—The sludge-pipe of the boiler should be made to discharge in some place visible to the fireman, as there is reason to believe that the imperfect closing of the said pipe has frequently led to unexpected diminution of the boiler water, and consequent explosion.

6.—It seems highly desirable that the water-gauge employed in the locomotive engines should also be applied to ordinary boilers, which gauge exhibits the state of the water within the boiler. It consists of a glass tube with stop-cocks.

7.—I cannot close these remarks without recommending the adoption of a fusible plug of the most esteemed alloy, such plug being placed at the upper part of the tube where such is employed, or in the side of the boiler where most exposed to the flue fire, such plug to be punched out and renewed from time to time to guard against the effects of oxidation.

Matthias Dunn.

REGISTER OF NEW PATENTS.

REMOVAL OF SCALE FROM STEAM BOILERS.

R. B. Lindsay, Millwall Brewery, Poplar, *Patentee*, April 12, 1856.

The object of the invention is the removal of the scale or deposit from the tubular flues of steam-boilers, by the employment of highly heated air or steam. Atmospheric air (or it may be steam) when highly heated by any suitable apparatus, such as that used in obtaining hot blast, or by passing the same through a fire, is made to enter and fill the boiler, and in some cases the tubular flues, by which means the scale or deposit will be caused to crack and shell off. It is desirable that the boiler and tubular flues should at the commencement of the process be in the cold state.

The boiler being empty, and quite cold, the patentee forces highly heated steam into the boiler, so as to pervade it on all parts. The introduction should be as low down in the boiler as possible. The heated air or steam is allowed to flow off at any opening or man-hole at the bottom of the boiler; from this opening or man-hole there is a communication with the chimney, which by causing a draft draws the cold air through the tubes and cools them internally. The air is heated by forcing it through a fire contained in a furnace similar to a cupola furnace, and communicating at the top with the interior of the boiler; or it may be heated by passing it through heated pipes; this is the method to be employed when steam is used, but steam will not (as when using air) require a fan or other blowing apparatus for propelling it through the heating apparatus and into the steam-boiler which is to be cleansed. The effect of thus introducing heated air or heated steam into a steam-boiler will be to cause the scale or deposit which is on the tubular flues to crack and separate from the metal surfaces, and the boiler will thus be quickly cleansed; the scale or deposit may then be removed from the interior of the boiler in the usual manner. It is found that the scale or deposit separates within twenty or thirty minutes; but the time will vary in proportion to the nature and extent of the scale.

In locomotive engines, a jet of steam is admitted to the chimney while the operation is going on, to increase the current of cold air through the tubes.

APPLICATION OF ASPHALTIC OR BITUMINOUS COMPOSITIONS TO BUILDING PURPOSES.

G. Bird, Glasgow, *Patentee*.*

This invention relates to the application and use of asphalte, or asphaltic or bituminous compositions, in the manufacture or production of various building and structural details, more particularly the copings, cornices, or coverings of walls and other erections. In applying it to the construction of copings, or the upper coverings, layers, or courses of walls, the asphalte or asphaltic composition is cast or moulded in blocks of the required form, and the coping blocks so made are built together upon the wall, to be covered and finished as stone coping is now applied. The inventor states that by the adoption of this system of building, good copings may be produced at about half the cost of the usual stone copings, whilst the process of manufacture secures perfect accuracy of form and detail in all the parts of the longest line of work. Similarly cornices, sills, the capitals of pillars, and other structural details may be moulded in asphalte, or asphaltic composition, at a very reduced cost, and with good and substantial effect. A great variety of building blocks for various uses may thus be made in asphalte or asphaltic composition, especially the finishing details, or those which are not subjected to any positive or direct weight or strain, but act more or less as ornamental covers or finishing projections. Another advantage named by the patentee is non-absorption of damp, and thus the copings for boundary walls, the gables of houses, plinths, top courses, cornices, and other structural details which may be produced in this way, act as protectors to the walls, as wet cannot penetrate through the asphaltic matter.

* This invention did not proceed to the Great Seal.

PAVING.

C. Jean le Melorel de la Haichois, Paris, *Patentee*, March 31, 1856.

These improvements consist in the employment of lime, sand, asphalte, caoutchouc, gutta-percha, and marine glue, and wood, for the purpose of forming an even and durable pavement.

A layer composed of lime and sand (beton) is laid down to the thickness of about five inches on the part to be paved, then a layer of asphalte mixed with stones to the thickness of about two inches is applied, after which a layer of asphalte, either alone or mixed with sand to the depth of about one inch, is laid down, in which are embedded at certain equal distances strips or bands of vulcanised caoutchouc or gutta-percha. In the last application a layer of asphalte of about half an inch in depth is first laid down, and afterwards the strips or bands of vulcanised caoutchouc or gutta-percha, or other analogous substances, of about half an inch in thickness, and from a half to three-quarters of an inch in breadth, so as to form squares or lozenges. The strips are placed from six to ten inches apart, and are secured together by iron hooks or ties, at a distance of three to five inches from each other, which hooks pass through them. Instead of using hooks, the strips may be bevelled at the edges, so as to be firmly embedded in and secured by the asphalte. When the strips are laid down, a second layer of asphalte is applied, so as to be on a level with the strips of caoutchouc. The paving may be constructed by first laying down on a bed or layer of asphalte, mixed with small stones, small cross pieces of wood (of about one to two inches in breadth and half an inch in thickness), injected, according to Dr. Boucherie's process. Upon these cross pieces are placed the

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strips or bands of vulcanised india-rubber or gutta-percha, prepared as herein-before described. As asphalte does not naturally adhere to caoutchouc, it is necessary to apply a thin coat of marine glue or other similar substance to those parts to be placed in contact with the asphalte before being laid down; the asphalte being hot will cause the marine glue to melt and adhere to it strongly. The strips of caoutchouc should be embedded in and secured to the asphalte during the cooling of the latter.

MANUFACTURE OF IRON.

J. G. Martien, New Jersey, U.S., *Patentee*, April 4, 1856.

In a former patent, dated September 15, 1855, the patentee describes a mode of purifying iron when in the liquid state after being drawn from the blast furnace by means of atmospheric air or steam applied below, and so as to rise up through the liquid metal. That invention consists in using or applying certain materials to the liquid iron thus subjected to the action of air or steam, for the purpose of assisting in purifying the iron. And these materials are applied to the iron in the liquid state in which it comes from the furnace, so that they shall become blended with or disseminated through the metal, so as to act upon every part of it as far as practicable.

When the iron to be purified contains sulphur, chlorine is used to purify the iron from the sulphur, and the chlorine being in a gaseous state, is blown into the iron, in the same manner as described in the patent of September 15, 1855, either alone or mixed with air, through separate tuyeres, or through the same tuyeres as the air employed in the purifying process. The quantity of chlorine used depends upon the quantity of sulphur in the iron, but such a quantity of the chlorine is used as will combine with and carry off all the sulphur.

When the iron to be purified contains sulphur and also some oxide of iron, hydrogen or carburetted hydrogen (coal-gas), is employed in order to reduce the oxide to a metallic state, and to combine with and carry off the sulphur; this gas is applied in the same way as chlorine; but if the gas be mixed with air, care must be taken not to mix the air and gas in such proportions as to form an explosive compound.

When iron contains either at the commencement or at any other part of the process oxide of iron as well as sulphur, it is found convenient first to use chlorine for the purpose of carrying off the sulphur, and afterwards to use hydrogen or carburetted hydrogen for the purpose of reducing the oxide to a metallic state. In order to assist in purifying the iron from silica and make it work more kindly, the patentee adds to the iron, as it flows from the blast furnace or immediately after, about three per cent. of oxide of manganese, either alone, or mixed with either of the materials mentioned hereafter. It is preferred to blow this oxide into the fluid metal by means of air, in the same way as the air used for purifying the metal is blown into it, or the powdered oxide may be blown in through the same tuyere as or together with that air. Oxide of zinc may also be used in the same manner in order to assist in decarbonising the liquid metal.

There is a well-known natural mineral or metallic substance called spathose ore, containing, as is supposed, carbonates of the oxides of iron and manganese, and some other elements. In order to decarbonise or assist in decarbonising the liquid iron to be purified, the patentee adds to it about five per cent. of the spathose ore, in a powdered state, and blows it through tuyeres into the liquid iron, in the same way as the oxide of manganese. In order to make the iron work more kindly, he uses together with the oxide of manganese or spathose ore, or mixed with them, about two per cent. of clay which is free from silica, and dries and powders the clay and adds it to the iron, in the same way as the oxide of manganese and spathose ore.

When chlorine is not used in purifying the iron, chloride of sodium may be used, mixed or together with any of the before-mentioned materials; but the patentee does not claim the use of chloride of sodium as any part of his invention. Instead of blowing the solid matter above-mentioned into the liquid metal, they may be added to it in any other way, taking care to stir up the metal, or use other sufficient means to cause them to be thoroughly mixed with it.

Claim.—The use or application of chlorine, hydrogen, carburetted hydrogen, oxide of manganese, oxide of zinc, spathose ore, and clay, for the purpose of purifying or assisting in the purifying of liquid iron from the blast furnace.

MANUFACTURE OF BAR IRON.

W. Clay, Liverpool, *Patentee*, March 24, 1856.

This invention consists in employing crude, or cast-iron, or fine metal, in the molten state, and reducing it to a granular form, in which state it is found more convenient and suitable for working up by the subsequent processes into bar-iron. The iron may be obtained either direct from the blast furnace, from which it may be run out in a molten state, or it may be melted down from pig-iron or scrap cast-iron; but from whatever source it may be obtained, the patentee proposes to reduce it to a granular form preparatory to its being submitted to the subsequent processes. The granulation of the iron is effected by causing the metal when in a molten state to run into water, after which the iron may be collected in a granular form, and be subsequently worked up by the ordinary processes into bars or other forms of wrought-iron. Instead of simply granulating the iron and obtaining cast-iron or refined metal in the granular form, as above mentioned, the metal may also at the same time be decarbonised or deprived of a portion of its carbon by causing the cast-iron when in a melted state to fall from a height through the air before reaching the water.

The molten metal is passed through a perforated metal or other plate, placed at the top of a tower, shaft, or well; it is thus divided into small particles, and by descending in this form from a suitable height, varying according to the nature and quality of the metal operated upon, the divided molten metal will during its passage through the air be decarbonised or partially decarbonised, and thus rendered more suitable for working up into bar or wrought-iron. Ordinary atmospheric air contains a considerable quantity of oxygen, and if the molten iron be finally divided the oxygen will act with considerable effect in decarbonising the iron while the latter is falling through the air. After the iron has passed through the perforated metallic or other plate, it may be allowed to fall into water, so as to further decarbonise the iron, and preserve the metal in particles of a granular form, like shot; or, if preferred, the water may be dispensed with, and the iron collected in a suitable vessel at the bottom of the tower, shaft, or well. It is sometimes found advantageous to charge the atmosphere (through which the metal is to pass) with an additional dose of oxygen or some other decarbonising gas or vapour, which will act more vigorously upon the iron than common air, and will more quickly deprive it of the carbon or a portion of the carbon which it contains. A convenient mode of supplying an additional dose of oxygen is by the decomposition of some of the salts of potass, such as chlorate of potass or nitrate of potass, which contain considerable quantities of oxygen. The decomposition of these materials must be effected by the application of heat, either by causing the red-hot molten metal in a granular state to fall upon a layer of the salt of potash that is to be employed for the purpose, or by placing the salt of potash in a retort and heating the same by a naked fire until oxygen is given off. Other materials, such as oxide of manganese, may be employed as the oxygenating material. Another method of bringing the oxygen into contact with the red-hot iron is by causing a blast or draught of air to enter the shaft tower or well down which the iron is descending. This air may also be heated by causing it to pass through hot tubes, which are heated in a furnace, or in the manner usually employed for heating the blast of reducing or smelting furnaces. Instead of forcing in heated air, it may be convenient to make use of superheated steam, which must be admitted into the tower, shaft, or well by suitable apertures. The steam should be superheated and made quite dry by any of the ordinary processes, otherwise the steam may have the effect of cooling down the iron as the latter passes through it.

The apparatus which the patentee employs consists of a tower, shaft, or well, of suitable height or depth, and provided at top with a perforated metallic or other plate, through which the molten metal is made to pass. By allowing the molten metal to fall through the ordinary atmospheric air a distance of about eventy feet a satisfactory result has been obtained. The patentee does not confine himself to this height, as the distance through which the molten metal is required to fall will vary considerably, according to the quality of the iron to be acted upon, or the peculiar nature of the concurrent arrangements for oxygenating the atmosphere through which the molten iron is to pass; if nothing but atmospheric air at the ordinary pressure is employed as the oxygenating agent, the molten iron will be required to fall

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through a greater distance than if the atmosphere be artificially charged with oxygen by any of the means above referred to. The particles of molten iron, after falling from a height through a body of atmospheric air, either in a natural state or charged with additional quantities of oxygen, and under pressure or mixed with superheated steam, may be allowed to fall into water at the bottom of the tower or well, or be collected in a vessel or reservoir.

The patentee does not claim the means herein mentioned of obtaining oxygen for the purposes of this invention, nor does he confine himself thereto, as other means of producing oxygen may be employed.

Claims.—1. The granulation of cast-iron (whether crude or refined), by causing the same in a molten state to run into water, as before described.

2. The granulation of cast-iron (whether crude or refined), by causing the same in a molten state to pass through a perforated metallic or other plate, suspended or placed in a tower, shaft, or well, down which the molten metal is allowed to fall in a finely divided state after passing through the perforated metallic or other plate.

3. The decarbonisation of cast-iron, crude-iron, or refined metal, by causing the same when in a molten state to fall from a height in a finely divided form through the atmosphere, or an atmosphere charged, either naturally or artificially with oxygen, or some decarbonising gas or vapour, either under pressure or otherwise.

VENTILATING STEAM VESSELS.

C. W. Williams, Liverpool, *Patentee*, March 29, 1856.

This invention consists in employing the ordinary rotatory fans, or other description of blowing or exhausting apparatus, worked by a small independent engine, or by being connected with the marine engine, to obtain an improved draught of air.

It is proposed to ventilate the cabins, hold, and other places by the exhaustion or propulsion of air in pipes circulating through different parts of vessels. Similar mechanical arrangements are also employed to exhaust the products of combustion from the engine boiler furnaces by the funnels, and thereby promote the combustion of fuel; or the patentee sometimes causes the air to be forced into the engine and stoke rooms, by which means the furnaces will be better supplied with air. The same fan or air-pump while exhausting one set of air pipes or passages may at the same time be propelling air in another set of pipes or passages, when required.

The patentee does not limit himself to any peculiar class of blowing or exhausting apparatus, or to the materials, dimensions, or situation of them.

Claim.—The application of air-exhausting or propelling apparatus worked by steam power, for ventilating the holds of steam-vessels, and increasing the draught of their furnaces.

ARTIFICIAL STONE AND CEMENT

F. Coignet, Paris, *Patentee*, November 26, 1855.

The object of this invention is the production of artificial stone, concrete, or cement from various combinations of sand, gravel, broken flint, broken stone, burnt or unburnt soil more or less clayey, cinders and coal refuse, scoriæ, wood ash, dross and residue of metallurgical works, natural or artificial puzzolanas with unctuous or hydraulic chalk, very fine sand, such as that of downs and heaths, or a silicious one, similar to that of Fontainebleau and Montmorency in France, and in the employment of such matters when compounded in the formation of houses and buildings generally, of one or many colours, mouldings and ornaments in relief, and all that comes under the head of masonry work. The matters to be mixed are pounded together, and when used the desired forms are given by moulding and compression on the wall or other formation, and repeating the operation till the structure desired is obtained, the whole without brick or stone facing, and without requiring to use any coat.

1. The material is composed of sand, grits, metals, and broken stones, adding a certain proportion of more or less clayey but crude (unburnt) soil, the whole being mixed with a certain proportion of ordinary or hydraulic lime.

2. It may be composed of sands, grits, metals, and broken stones, with cinders and scoriæ of coals and metals, of more or less clayey earth, but burnt, and with natural or artificial puzzolana, adding these various materials either jointly or separately and mixing to the whole a certain proportion of ordinary or hydraulic lime.

3. The patentee composes it also with very thin sand (such as landes, downs, sea sands, sands similar to those of Fontainebleau and Montmorency, marly or clayey sands), with addition to coal or metals cinders and scoriæ, more or less clayey soil but burnt, natural or artificial puzzolana, and especially, if necessary, of marly or clayey but burnt sands, the whole being mixed either jointly or separately with a certain proportion of ordinary or hydraulic lime.

For the manufacture of the concretes, the ordinary or hydraulic lime is used slackened on the ordinary plan, in order that it may form a paste as solid as possible. The cinders and scoriæ of coals, the burnt clayey earth, the metal ashes and scoriæ and the natural or artificial puzzolana must be used under the form of very thin powder, their tenuity giving much more energy to their action, and consequently permitting their quantity to be considerably lessened, as also that of the ordinary or hydraulic lime. In places where coal cinders are abundant it will be unnecessary to grind them to powder, and they may be used as supplied from the furnaces; in such cases a greater proportion of cinders is to be employed for the manufacture of the concrete, and the cinders can even be used alone with lime. The sand, gravels, or grits must be as clear as possible of clayey soil or crude marls.

The mixture of the various materials that are to compose the concrete is effected by machinery. It can be completed at once, but then the operation is more difficult, and requires more time and care without ever giving a concrete wholly homogeneous. The following process is preferred: To prepare the concrete No. 1, ordinary or hydraulic lime is mixed with the sand, grits, gravels, and broken stones, by crushing; and by a second grinding the mortar obtained by the crushing clayey crude soil is mixed. In this case the crude earth must be wetted or crumbled, so that it may become easily divided and speedily mixed. To prepare the concretes Nos. 2 and 3, by crushing ordinary or hydraulic lime it is mixed with the coal cinders and scoriæ, burnt earth, metal cinders and scoriæ, natural or artificial puzzolanas, and also the burnt marly or clayey sand, if employed; all the latter materials can be put in the mixture jointly or separately. Afterwards the mortar obtained by the first crushing with the sands, grits, broken stones, and thin sands, is mixed. The above concretes, whatever may be their composition, must be obtained as a very solid and almost pulverulent paste, in order to resist the percussion of hard bodies, and also to agglomerate better. When the concrete is perfectly pounded, and has the appearance of a very thick paste, it is cast in a mould established on the wall itself, or on the place where a work of masonry is to be built, and either above or under the ground. The mould has in the interior the shape of the intended part of building; thin layers of concrete are cast into this mould established on the wall, and it is moulded, rammed, or compressed by the repeated percussion of some hard and weighty body. When the mould is filled, it is disjointed and brought to any other place to be filled again. By the use of this concrete in moulds on the wall, any building whatever, either solid or hollow, or in relief may be erected, and by the moulding of the concrete on the wall, a monolythe building can be formed, whatever may be its mass, height or disposition. The same concretes can also be used to manufacture bricks, tiles, pipes, and artificial stones of any description or shape, by means of piling and compressing in moulds specially disposed, and having in the interior the form of the desired object. By this concrete any constructions may be built without any facing, casing, or basement whatever of stone or bricks.

A new description of floorings is produced by laying iron stop planks on the walls to support the flooring, parallel one to another, and reposing on the walls by their ends, so as to be completely supported by the whole thickness of the wall. The number and strength of the iron plank is in proportion to the pitch, and to the area of flooring to establish; or iron rods placed at convenient distances apart one from the other may be used, traversing through and through the four walls supporting the flooring, so that these iron rods cross symmetrically one another, and look somewhat like a chess-board. These rods having a screwed nut at each end, will prevent the walls from losing their perpendicularity. The plastic material is poured on the false flooring, and rammed or compressed, until the beams, planks,

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and rods be wholly covered by the concrete, and the total thickness of the flooring be attained. The surface of the flooring must be levelled according to the pattern, and when hard the false flooring is taken away. In order to increase the hardness of these floorings, and avoid the alkalinity of the lime, the surface may be washed with a solution of biphosphate of lime. When this operation is finished, a coating of paint is given to the lower part, and a coat of encaustic on the part above, to complete the flooring.

Claims.—1. The introduction in the composition of concretes or plastic material of certain hydraulifying substances in the form of thin powder, such as the coal cinders and scoriæ, metal works cinders and scoriæ, burnt clayey earth, natural or artificial puzzolana; which substances easily combine with lime, increase the quickness and energy of the hardening of hydraulic lime and admit of lessening the quantity of lime to be introduced in the concretes or plastic materials without any prejudicial action as to the solidity.

2. The composition, preparation, and manner of employing the concrete or plastic material into which is introduced more or less clayey crude earth, which allows of reducing the quantity of lime, and consequently to lessen the cost.

3. Obtaining concrete by means of thin sand, so that this concrete becomes quickly hard and convenient for any building purposes.

4. The use of the biphosphate of lime, in order to increase the hardness of the surface of the concrete to render the same impermeable, and to destroy the alkalinity of lime, which allows the application of paints having a fat or resinous basis.

CEMENT.

H. Y. D. Scott, Chatham, *Patentee*, April 17, 1856.

The patentee prepares from common quick lime a substance which will, when ground to powder and made up with water, set somewhat after the manner of Portland cement, and gradually attain a very great degree of hardness, thus differing essentially in its action from the preparation of lime as ordinarily used. Quick lime, prepared by any of the ordinary methods, is introduced between two perforated and perpendicular brick walls contained in a kiln, which is also furnished with a fireplace, to allow of the lime being raised to the required temperature. The roof of the kiln is arched, to reverberate the heat through the lime, and the distance between the perforated walls containing it may vary from one to two feet and upwards, according to the size of the kiln. When the lime is raised to a dull or cherry-red heat, the firing is raked out, and iron pots containing ignited sulphur are then to be introduced into the kiln, taking care that they are so placed as to be protected from such a heat as would cause rapid ebullition of the sulphur, and allowing no further access of air than will find its way into the kiln when the flue is shut and the ash-pit and fire door closed. This process may be carried on in kilns of various forms, and a more equable distribution of the sulphurous acid is obtained when the lime is placed on perforated horizontal floors, the above-described form being used only on account of the greater facility which it offers for charging and discharging. The effect can also be produced on the lime while still in the kiln in which it has been burned, but this method of procedure is found precarious, from the difficulty of adjusting the temperature, and of producing regularity of action by the sulphurous acid throughout the mass. The lime may be used in lumps of the size of a cocoa-nut, more or less; and in a well constructed dry kiln, one pound of sulphur is a fair allowance for each bushel of lime operated on, but the larger the kiln, the more the process should be prolonged. In a laboratory experiment where a rapid current of sulphurous acid can be passed through a heated glass tube containing the lime, the required change can be effected in a few minutes. When four or five bushels are operated upon in a kiln, as described, the process is continued for two and a-half hours; and with a kiln containing two yards, or thereabouts, it is advisable to continue it for six or seven hours, more or less. Limes prepared from argillaceous limestones or chalks give better results than pure lime, but where the clay is present in sufficient quantity to yield a cement by ordinary burning simply, nothing would be gained by making use of the above process also.

Claim.—Subjecting quick lime, in a heated state, to the action of sulphurous acid, for the purpose above-named.

MANUFACTURE OF IRON.

C. Sanderson, Sheffield, *Patentee*, November 24, 1855.

This invention relates to a mode of refining iron, or ridding it of various impurities by the admixture of certain chemical ingredients with the raw iron when in a fluid state.

Sulphate of iron is the most convenient and economical substance to be used. The patentee considers that the acids or that part of the substance which contains oxygen acts principally on the impurities to be removed from the iron. Earthy or alkaline salts containing oxygen, may be employed in proper proportions in conjunction with other materials, such as manganese and clay, and added to the fluid iron with great advantage. When these materials are added to the fluid iron, carbonic acid gas or carbonic oxide will be produced by the decomposition of these substances, and by the union of the oxygen contained therein with the carbon contained in the fluid iron. The carbon is eliminated from the iron, and the gas so produced either passes off in the form of vapour, or acts upon the silicates or earthy metallic compounds which may be contained in the crude iron, and by so doing will separate the metallic particles from the earthy matters and precipitate the former, the earthy parts being allowed to flow away in the shape of slag; the iron may then be run off in a much purer state than heretofore.

The iron to be operated upon may be obtained in a fluid state, either by melting common pig iron in an ordinary reverberatory furnace, or it may be run out direct from a blast furnace. The operation of refining should be conducted in a reverberatory furnace, and having skimmed off the slag which rises to the surface of the metal, the chemical re-agent may be added, and, if required, it may be mixed with iron by stirring the fluid mass.

The quantity of the sulphate of iron or other re-agent found necessary for refining one ton of pig iron is from twenty to forty pounds weight, according to the quality of the iron and the nature of the re-agent employed. For mottled forge iron twenty pounds of sulphate of iron is added to the melted iron; for grey iron, thirty pounds; and, for No. 1. foundry pig iron, forty or more pounds to the ton of metal is employed. These proportions, however, will necessarily vary, not only from the varying quality of the iron operated upon, but also according to the nature of the re-agents employed.

The sulphate of iron or other chemical re-agent should be allowed to act upon the fluid iron for about one hour, and the workman will know that the operation is completed when he finds the iron thicken or become creamy. The furnace may then be tapped, and the refined metal be run out into any convenient receptacle, so that the metal so refined should by its gravity separate itself from the flux and impurities, which may be removed in any convenient manner, and an iron of very superior quality will then be produced and may be run off into moulds.

The patentee is aware that crude iron has been decarbonised and refined to some extent by the employment of a blast of air; but that he considers an expensive, inconvenient, and unsatisfactory process, and proposes to dispense with it altogether, and employ instead the chemical fluxes and re-agents above-named, as more economical and effectual.

Claims.—1. The decarbonisation of raw or crude pig iron, melted on the bed of a reverberatory furnace, or obtained in a molten or fluid state direct from the blast furnace, by adding to such melted metal and chemical re-agent which by its decomposition will evolve elements capable of combining with the carbon, and reacting upon silicon, aluminum, sulphur, phosphorus, arsenic, or any other deleterious substance or impurity contained in the iron, and will, by the generation of carbonic oxide or carbonic acid gases (which will not combine with the iron, and will necessarily fly off or enter into combination with the scoria and earthy matters), cause them to separate from the iron, the impurities contained in the metal being thus got rid of either by volatilisation, or by reason of the difference in the specific gravity of the various substances.

2. The use of sulphate of iron or its chemical equivalent for the required purpose, by adding it to cast iron when it is being melted for the purpose of producing castings of beams, shafts, and other articles requiring a particularly good iron, and thereby purifying such metal by discharging the earthy and other deleterious matter contained therein, and adding greatly to the strength of such castings.

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MANUFACTURE OF IRON.

W. Armitage and H. Lea, Farnley, *Patentees*, April 16, 1856.

This invention relates first to the manufacture of cast iron as reduced from its ores, and consists in combining and introducing steam along with cold blast into the smelting furnace, for the purpose of getting rid of a great portion of the sulphur, phosphorus, carbon, and other impurities contained in iron, and thus purifying the same during the smelting thereof.

The second part of the invention relates to the further purification of the iron, smelted as above stated, after it has been run into pigs, and consists in operating upon the pigs in a refinery furnace with steam and cold blast, as stated, for the purpose of preparing the iron for the puddling furnace; this invention applies specially to the manufacture of iron intended to be rolled into plates for the use of boiler makers, in the manufacture of locomotive and other steam boilers, and other vessels required to stand great pressure, as the iron thus manufactured is free from blisters, is tougher and denser, and in all respects better adapted for the use of boiler makers than boiler plates as heretofore manufactured.

The steam from a boiler is conveyed into a steam chest, or receiver, from whence the steam passes into an air-pipe, in which the steam, as it enters, mixes with and is taken up and along with the blast. and is forced into the blast furnace through the nozzle pipe by a fan blast. In operating upon the ores of iron, during the smelting in the furnace in the first stage of manufacturing cast-iron, it is found in practice that the best results are obtained when the pressure of steam to the blast is in the proportion of about 7 lb. of steam per square inch to about one pound and three quarters of blast per square inch.

Claims.—1. The combining and admixing of steam with atmospheric air or blast, and the employment thereof in blast furnaces used in the manufacture of iron, as above described, so that the blast and steam shall enter the furnace in combination.

2. The use of steam mixed with the blast as above stated, and the employment thereof combined in refinery furnaces for still further purifying the iron which has been smelted in the blast furnace, as above stated.

SEASONING TIMBER.

P. W. Barlow, Great George-street, Westminster, *Patentee*, April 18, 1856.

The object of this invention is seasoning timber, and consists of causing air to pass through the timber in such a manner as to drive out the sap, and when the timber has been impregnated with liquids of a preservative character, the air is used to drive out those fluids. The air used may be in the natural or heated state. The arrangement of apparatus for causing air to pass through the timber may be varied: but it is preferred to employ compressed air, and to introduce it at one end of a piece of timber, and to drive out the fluid at the other end by the passage of the air through the pores; or the air may be introduced into a cut or cavity intermediate of the length of the piece of timber, and the fluid be driven out at each end; or exhausting apparatus may be applied at one end of the timber, and the other end be left open to the atmosphere, so that the air will flow through the timber to the vacuum. In either case the air passing in a direction from end to end of the timber will force out the sap or other liquids, and dry or season the timber in the interior.

Compressed air is preferred for the purpose of this invention, which may either be at the natural temperature or heated, but it is better to commence with the air at the ordinary temperature, in order to express out the sap or fluid before forcing in heated or dried air, but the whole process may be performed with air in the unheated state. At the end of a stick of timber a plate of metal is fixed, and either by a ring of vulcanised india-rubber, or by other suitable material, the edges are packed so that the air forced in between the plate and the end of the stick of timber may not pass in that direction, but be compelled to find its way through the timber; or instead of using compressed air, the space between the plate and the end of the timber may be exhausted by an air pump, when the pressure of the external air will cause air to pass through the timber towards the vacuum; or instead of using a plate at the end of the timber, any length of the piece or stick of timber may be enclosed in a strong vessel; one end being open to the outer atmosphere, the parts where the timber passes through the vessel being packed or closed air-tight, when on air being forced into this vessel, or on its being rendered vacuous, the air will force its way through the timber, and the same will drive out the sap and liquid, and the timber will become quickly seasoned; or a saw cut may be made midway in the length of the timber, and be packed at the outer parts, and then air be forced into the space caused by the cut.

Claim.—The causing streams of air to pass through timber or wood, in order thereby more quickly to season such timber.

THE SEWERAGE QUESTION.

Sir,—The economy of nature, animate or inanimate, furnishes numberless analogies for the uses of science; inventions being usually but the practical appliances of these analogies to the accomplishment of mechanical or chemical results.

Thus, springs rise through fissures to the level of their sources; and we follow Nature's teaching in the construction of Artesian wells, by piercing the intervenient impermeable strata, and bringing deep-seated water to the surface, for purposes of health and convenience.

Again, the converse of this phenomenon is exemplified by the disappearance of streams through faults or fissures in certain localities; and why not follow the teaching of Nature here, also? and for like purposes, by disharging superabundant or injurious fluids (sewage of dwellings and drainage of marshes) through culverts, sunk to a permeable bed, wherever the relative superposition of strata allows of such a remedy. This could not deteriorate the water of Artesian wells, because an impervious bed (or beds) intervenes; while, on the other hand, all impurities must be neutralised or destroyed by diffusion and absorption, before the water reaches the surface again, or comes in contact with wells or springs at considerable distances.

The adoption of such a plan would tend to prevent rivers, which Nature supplies for salubrious uses, from becoming the prolific sources of disease and death; and the quick fall of the main ducts would transport beyond the probability of deleterious effect, those fetid semi-fluids, that now creep up the walls of houses by capillary attraction, and saturate the very soil itself by their sluggish foulness.

Scavengering and atmospheric influences may suffice (even without flushing) to clear off all superficial impurities, and gully gratings, so injurious to the public health, would become unnecessary, while the soakage or transpiration from house drains might be altogether prevented by trapping, and the use of earthenware pipes glazed on the inner surface.

A long period must elapse before accumulation of solid material could obstruct the flow or absorption of the liquid sewage; but, as any plan is imperfect without the utilisation of this material, there would be little difficulty in adapting the principle of the dredger to draw up these accumulations, at certain intervals, through the main culvert itself, or through shafts communicating with one or more reservoirs along its course; and these shafts would also serve to carry off the miasma into the atmosphere.

Baked clay, pulverised, may answer sufficiently well for a deodoriser, and would give more solidity to the manure than peat charcoal, thus facilitating its transport, as well as economising its use.

The plan proposed may be deemed too expensive, or altogether impracticable in some localities, from the nature of the geological structure, and, in other instances, inadequate to convey the sewage of extensive districts. Admitting the latter objection, it is met by increasing the number of the main ducts, or restricting the area of application; and, in any event, cannot refute the fitness of the plan, or the truth of the natural analogy on which it is founded.

These suggestions are not put forward as solely applicable in every case, but rather as auxiliary to other plans; and, in conclusion, I would observe, that whatever modes be adopted, in this age of great cities, for assigning to sewage refuse its place in the reproductive cycle of Nature, without injury to the public health, it is vain to expect successful result apart from the supervision of a well-instructed and diligent sanitary executive.

Dublin, Nov. 1856. John Locke.

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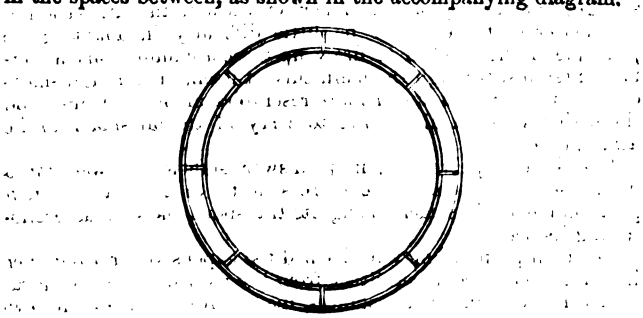
DESTRUCTION OF AN ANNULAR TANK.

THERE is an existing dispute between the contractors for erecting a large gas-holder of a peculiar construction at Hamburgh and the gas company of that city, which presents several features of engineering interest.

An ordinary gas-holder, it is well known, consists of a large circular iron tank, with perpendicular sides, to hold water, in which the gas-containing cover rises and falls. The weight of iron and water makes it necessary to have a solid foundation whereon the tank may rest and be maintained in a perpendicular position. The site of the gas works at Hamburgh being marshy ground, such a solid foundation could only be obtained by piles, and to avoid the labour and expense of driving piles over the whole area to be covered, the engineer devised the plan of forming a ring of piles and of erecting an annular tank upon it. The water in which the gas-holder would float was therefore contained in the annular space between the double sides of the tank. The middle space might be either filled with earth or be left empty, without affecting the action of the gas-holder. The contractors finished the work, and there is reason to believe it would have answered the purpose remarkably well, if it had been allowed to remain as when completed; but in order to protect the water in the tank from the frost, it was determined to fill the interior space with earth. This was thought desirable, because the intensity of the frost at Hamburgh usually solidifies the water in the gasometers, and necessitates the use of heated water; the space was accordingly filled in with clay and sand, the pressure of which against the inner surface of the tank forced it outwards, and rent the side from the top to the bottom; the outer circumference also yielding to the pressure, making a complete wreck of the large and costly structure. The gas company charge the contractors with not having properly executed the work, whilst the latter contend that they are not answerable for the damage, and that the fault lies in the original design, and in the filling up the middle space, for which they are not responsible.

There seems to be not much doubt that the tank would have been sufficiently strong and durable had there been no external pressure, and that the annular gas-holder would have been a success instead of a failure, but for the filling in with yielding materials. It appears, however, that the engineer contemplated the filling up, but the provision for resisting that pressure was inadequate for the purpose. The plan adopted was to surround the sides of the tank with thick iron hoops at short distances apart, with the view of preventing the iron plates from bursting asunder, and the manner of applying the hoops is alleged to have been one cause of the disaster. They were made to bear upon the flanges of the plates without having bearings in the spaces between, as shown in the accompanying diagram.



It is evident that by this method of applying the hoops, the resistance was thrown on the edges of the flanges alone, and the strength derivable from equable distribution of the resisting force was lost. Thus when the strain came on the flanges, the segments of the circle of the hoop contained between the bearing points stretched, and the rivets were forced; the plates being torn asunder, and rents made in several places from the top to the bottom of the tank. Near the points of fracture the hoops were straightened, thus showing the defective plan of the stays, and the want of a bearing surface between the ridges on which the hoops rested.

Without this practical illustration of the want of intermediate bearings, it might have been contended that as the object of the hoops was to resist the general pressure outwards, the plates being strong enough to resist the pressure against them separately, it was only necessary to hold them together at points near to each other. The destruction of the gas-holder at Hamburgh shows the fallacy of such a notion. To apply a hoop in that manner is similar to fixing a curved wrought-iron stay inside a steam-engine boiler; the power to resist does not in that case depend on the cohesive force of the particles of the metal, but on its rigidity, or resistance to bending. Thus the strongest fibrous iron so applied would make the feeblest stays.

The question in dispute between the Hamburgh Gas Company and the contractors has been submitted to arbitration, and we believe it is not yet decided.

THE SUBMARINE SYPHON.

AN experiment recently was made in the Thames, in front of the new Houses of Parliament with a novel and ingenious diving apparatus bearing this designation, the invention of M. Danduran, a French civil engineer, already known in Paris for several useful contrivances. The trial of this instrument, made under the direction of M. Danduran himself, was witnessed by several scientific gentlemen and others well able to form a correct opinion of its merits, including Mr. Charlier, the secretary of the Royal Humane Society; Mr. Page, the principal engineer at the new bridge, Westminster; and Mr. Graham, the resident engineer there, the two latter of whom have had great experience in the operations of diving-bells while the foundations of the intended structure were being laid. A complete and efficient apparatus for conducting submarine operations with ease, at considerable depths below the surface, has long been a desideratum. The ordinary diving-bell, diving-helmet, and other similar contrivances, though answering the purpose for which they were designed with more or less efficiency, have never, it is said, overcome a difficulty incident to them all, arising from the increased pressure of the air within the apparatus as it descends lower in the water, which renders it unsafe for a human being to descend much more than about 40 feet, for with the pressure increasing at a rapid rate as the instrument sinks, it would soon reach a limit at which respiration would be impossible. This great difficulty has been overcome, it is said, by the contrivance of M. Danduran, which is simple and effective. His apparatus consists of a copper bell, in shape not unlike an ordinary umbrella partially collapsed, fitted with glass plates, and sufficiently large to cover the diver to the waist. Beneath this is slung a saddle of lead, weighing 150 lb., which serves the double purpose of a seat for the diver, and of sinking the bell in a vertical direction. A strong gutta-percha tube, about an inch and a-half in diameter is passed through the bell, entering at one side and coming out at the corresponding one on the other, on a line with the mouth of the diver when he is seated inside. Both ends of this tube are kept above water, whatever depth the diver may descend, and to that portion of it which comes in contact with his lips a flexible mouthpiece is attached, perforated like an ordinary respirator, by which he is not only enabled to breathe with freedom, but to hold verbal communication with the persons in charge of the apparatus at the surface, who are thus put in a position to direct his submarine operations with comparative ease. When, under the existing practice, a diver dons his helmet with its leaden cuirass, and his immense *sabots* with soles of lead an inch thick, he is almost borne down by the immense weight he carries, which, though absolutely necessary to sink him, greatly impedes the freedom of his operations under water. Besides, he is only kept alive by an air pump constantly working on the surface; and through any accident to this, or want of attention in those charged with its operation, he might die before he could be hauled above water. He has, too, no means of communicating with those on deck nor they with him, except by tugging a rope; and if they want to give him fresh directions they must pull him up to the surface to communicate them and then immerse him again. M. Danduran's diver, on the other hand, sits jauntily aside his leaden saddle, habited only in a light waterproof dress, with his arms and legs always at perfect liberty, for, unlike the man in the helmet, he sits on the lead which sinks him instead of sustaining it on his shoulders and feet, and he can always hold verbal intercourse with the people on deck. To one extremity of the tube on deck a fanning apparatus is attached, resembling a small coffee-mill in size and appearance, and when this is set in motion a current of air at the ordinary pressure, no matter what depth

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he may be, is conveyed past the mouth of the diver, which he can breathe with comfort. The chief uses of the apparatus are to examine ships' sides and bottoms while at sea, to discover and stop leaks, to recover lost property, to fish coral, sponges, and mother of pearl, to guide the laying of electric cables, and especially to inspect them and discover the point of separation when the electric communication is broken, to which purpose it seems admirably adapted. The French Minister of Marine appointed several commissions to examine into the capabilities of the invention, and their report was of so favourable a nature that orders were given to M. Danduran to supply some of the French seaports with the apparatus. During the recent experiments, Mr. Page and Mr. Graham expressed a strong opinion of its superiority over the diving-helmet, of which it is a little more than a third the cost. M. Danduran is now endeavouring to bring his invention into use in this country. It would seem to be well worthy the notice of the authorities at the Admiralty, as it would be as much an appendage of every large ship as its anchor or compass.

G. A. LEWIS'S APPARATUS FOR RAISING AND LOWERING SCREW PROPELLERS.

(*With Engravings, Plate* XXXVIII.)

It must be obvious to those who know what a sea voyage is, that all kinds of apparatus intended to be employed on board sea-going vessels, should as far as possible combine the utmost simplicity of construction, with compactness and facility of working under the most adverse and trying circumstances—circumstances which have but too often set at nought the calculations of ingenious men, who have studied to improve our nautical machinery, but in so doing have lost sight of the vast difference of the conditions under which mechanical contrivances are brought into action in a heavy sea-way, and those under which they are tried on "terra firma." Hence have arisen numerous failures of nautical apparatus at times of the greatest emergency, and a consequent fearful loss of life and property.

Mr. Lewis, of Bristol, of whose invention we give two views, partly in section, in Plate XXXVIII., has, in the course of long sea voyages, had an opportunity of observing the inconveniences attending contrivances at present in use for raising the screw propellers of several first-class vessels fitted with auxiliary power, and has endeavoured—we think successfully—to improve upon them. The plan he has patented is exceedingly simple and compact, and is free from serious objections to which some other arrangements are liable. From the screw being made use of as the means of raising and lowering, the action of the apparatus—unlike that of those in which chains, &c. are employed—will be certain and steady in the heaviest sea, and the power attainable is almost unlimited. The propeller when out of use is snugly berthed under the stern of the vessel, the screw of the lifting apparatus being turned down upon deck. The lift is moreover so constructed that after having been employed to deposit the propeller in its working position, it can be detached and drawn up entirely out of the way of accident, or of offering any impediment to the vessel's progress. The frame or lift employed slides vertically between the stern and rudder posts, its upper extremity terminating in a shank, which passes upwards through the after deck. To this shank is jointed a strong screw passing through a nut fixed above the deck. This nut is free to revolve in its bearing, and when raising or lowering the propeller, is driven round by bevil gearing actuated by manual or other power. When the lifting screw is not in use, the joint before mentioned enables it to be turned down on deck or to be removed, as desired. The lower extremities of the lift are fitted with pins having their lower ends formed with T heads, which take into corresponding holes formed respectively in a clutch-block attached to the inner end of a short shaft upon which the screw propeller is fixed, and a block or bearing in which the outer end of the same shaft works. In these blocks are formed grooves, which fit upon and are guided in their vertical movement by the stern and rudder posts. The outer end of the *inner*, or main driving-shaft, is fitted with a clutch-block, the feather of which corresponds in thickness with the stern post, with which, when in a vertical position, it coincides. In its working position this feather takes into the groove in the block which is attached to the inner end of the short outer shaft, and carries it round, the junction of the two shafts being completed by bolts, which are readily removable by the engineers. The bearing in which the end of the outer shaft works, and which slides on the rudder post, is held down by a spring attached thereto above the bearing. On its being required to raise the propeller, the lift is lowered, and on reaching that part of the rudder post to which the spring is fixed, commences to push back the spring, which, on the lift reaching its destination, will have been forced back into a recess provided for it entirely out of the way of the bearing. The bolts at the junction of the two shafts are then withdrawn, and the pins situated at the lower extremity of the lift (having entered the holes provided for them in the blocks of the outer propeller shaft) are, by means of rods, which are placed in position on the lift before it leaves the deck, turned round during one-fourth of a revolution, whereby the T heads are made to lie across the holes and prevent the withdrawal of the pins. Hence it will be obvious that on the lift being raised, it will carry the short shaft and propeller with it to any required height, where both may be secured. When necessary, the propeller is again lowered until the before-mentioned blocks come in contact with stops so placed upon the stern and rudder posts, as to check the descent of the propeller when the centres of the inner and outer shafts are in such a position as to coincide. The T headed pins are then turned, so as to pass freely out of the holes in the blocks, and the frame or lift is drawn up by the lifting screw, which is then turned down upon deck or removed at pleasure.

ARCHITECTURAL IMPROVEMENTS OF LONDON.

No. VII.

The last of our modern club-houses recently erected is that called the "Junior United Service," occupying the corner of Charles-street Haymarket, and Regent-street. The external work of this large edifice is now nearly completed. In this example, as in others of a similar class which we have already noticed, the Italian style of architecture is adopted; abandoning, however, all the set rules of Palladio and Sansovino as far as regards the employment of columns or pilasters in the vertical divisions of the façades. Similar to all the modern club-houses in Pall-mall, this structure consists of two stories only above its sunken basement, and occupying a highly prominent external angle, we have a full view of its two principal fronts. That in Regent-street has two large projected windows in its centre, and minor ones on each side inserted in the straight portions of the walls. Over the upper central one is a segmental-headed pediment, in the tympanum of which is a large Olympian Jupiter-looking head, decidedly too large for its position, and evidently requiring to be chiselled down into something like good proportion. On each side of this head are recumbent boys. By the jambs of this window are columns with plain shafts enriched by badly-defined Composite capitals. Over the pediment on a plinth are two female figures with a line between, and wanting others to balance them laterally, on which view they have an extremely awkward effect. The lower bay-window underneath this composition is much plainer in its decoration, having a head of Minerva as the key-stone of its circular-headed arch, and columns on each side surmounted by a plain entablature. The minor windows on this elevation are comparatively plain in their dressings, and of the same design as those on the larger front of the building in Charles-street, the upper range of which have segmental and angular heads alternately, supported by plain columns with composite capitals, and at their sills square-moulded ballusters. The whole series of the lower windows are square-headed, and the cornices over them supported by plain trusses over narrow pilasters in which are sunken panels. Unfortunately, the Charles-street front is completely spoiled by two blunders; firstly, the principal entrance on this side is not in the centre; and secondly, there is an ugly canted projection at the Haymarket end that has nothing whatever to balance it.*

The entrance is composed of a heavy arched doorway in a large hollow, in the jambs and soffit of which are inserted great, staring, Gothic-looking pateræ, or Tudor roses, which in

* It is believed that the architects of the structure are not accountable for the spoiling of this front, as regards the "ugly projection" to which we allude, as we understand it was the peremptory wish of some members of the club that this inconsistency should be perpetrated.

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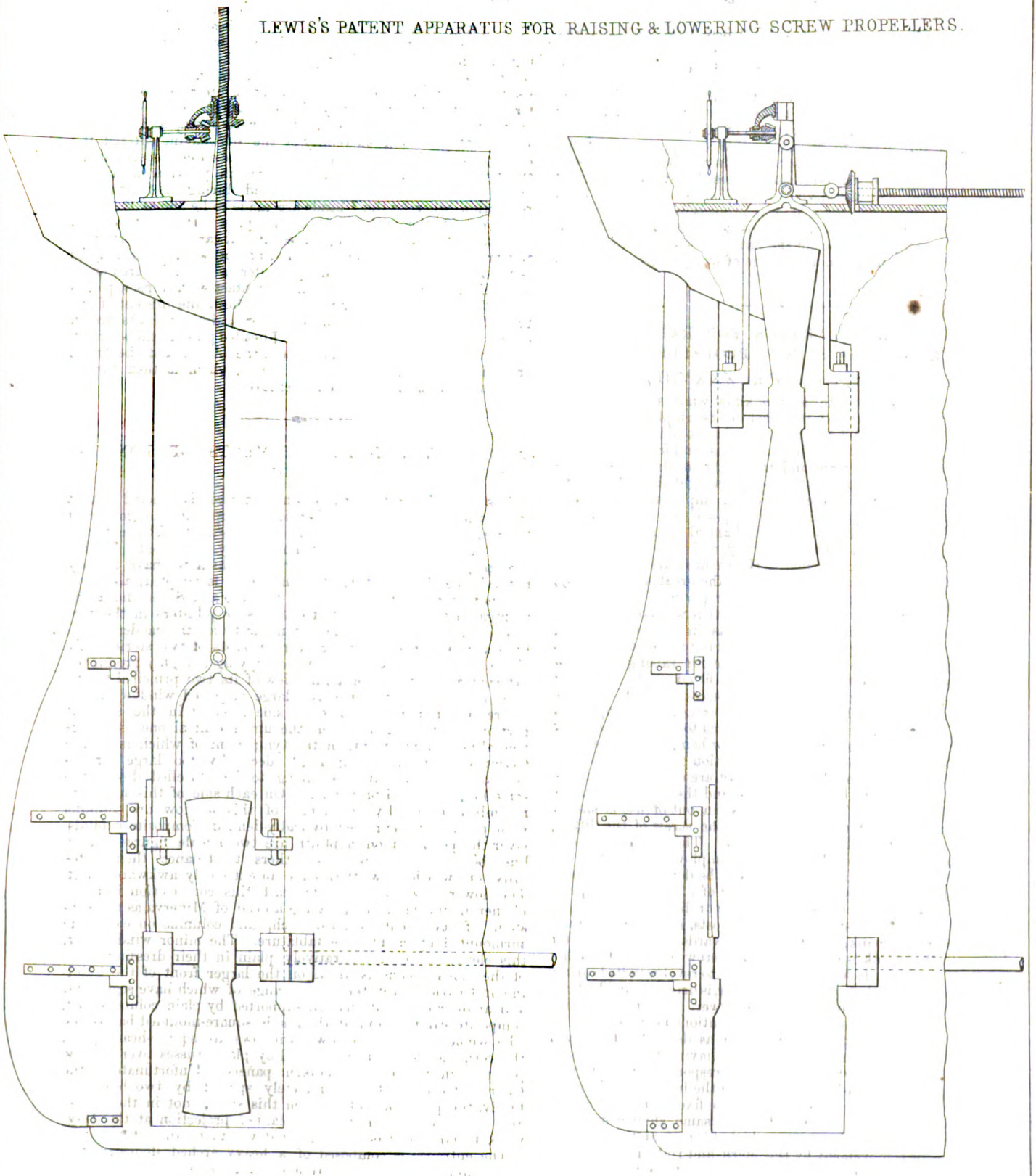
LEWIS'S PATENT APPARATUS FOR RAISING & LOWERING SCREW PROPELLERS.



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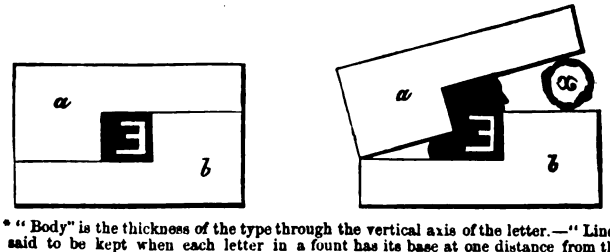
a great measure destroy the character of this portion of the edifice. The Charles-street front extends to St. Alban's-place, and has in its first-floor a range of ten windows. The two façades are surmounted by a large, heavy, enriched cornice, which has neither parapet nor blocking-course over it. The carved embellishments of this building are coarse and vulgar in the extreme, and quite devoid of that elegance and refinement of design and execution which so eminently distinguishes those on some of the club-houses and other structures which we have previously described. This remark, we regret to observe, applies equally to the principal enrichments of the interior, particularly in the modelled plaster-work of the ceilings, which, although in some instances the general design is praiseworthy, are remarkably faulty in detail, and completely wanting in that sharpness, life, and "under-cut" which should always characterise superior work of this particular description. Both the external elevations have the same fault to which we have alluded in a portion of our previous comments; viz., that there is a very unequal and injudicious distribution of plain surface in proportion to the moulded work, which is very glaringly apparent in the space between the tops of the upper windows and the lower line of the large cornice at the eaves of the roof. In fact, externally, we fear the structure contains no features in it to class it beyond heavy and ill-proportioned mediocrity. The interior contains many apartments of noble proportions, which are being fitted up with a considerable amount of taste and splendour. The entrance vestibule enters immediately upon the grand staircase, on the first landing of which are caryatide figures cut in Caen stone, with others on the walls at each side to correspond. The walls of the entrance are panelled in the same material. On the right, as you enter the vestibule, is the members' coffee-room 66 feet long by 41 feet wide; in front and at the back the strangers' coffee-room, 55 feet by 21 ft. 6 in.; also the house dining-room, smoking-room, and numerous offices. On the left of the entrance is the morning-room, 61 feet long by 30 feet wide; these larger rooms have all a uniform height of 22 feet in the clear. On the first-floor is the reception-room, which is 31 ft. 6 in. long and 23 ft. 6 in. wide; the writing-room, 61 feet by 30 ft. 6 in.; the library 66 feet by 26 feet, all of which, like the lower rooms, average 22 feet in height. On this floor are also the billiard-room, card-room. and the secretary's offices. The culinary departments are fitted up with every modern improvement.

TYPE FOUNDING.

It appears strange that, in this mechanical age and in this most mechanical country, we are still dependent on hand-labour for our printing type, and continue to use, virtually, the same moulds, matrices, and materials as our grandfathers did. Some type-metal is wanted, harder and more durable than that which found favour with printers when George the Third was king. Paper is made, cut, and printed by means of steam machinery, —cannot type be made by similar agency? It is, no doubt, very difficult to cast minute parallelopipeds of metal each having a letter properly set at one end, exactly rectangular, of *one* size, and of precisely the *same* length. "Body," "Line," and "Height-to-paper,"* must be accurate: and, indeed, in this case, the allowable limit of deviation is almost nothing; for as types are used together in numbers, a very minute error in each, accumulated, becomes unbearable to the eye of the reader.

The venerable hand-mould requires intelligence in its use. The following diagram will aid our explanation. Not to enter into unnecessary details, a rough section of the hand-mould parallel to the face of the letter will be sufficient for our purpose;



* "Body" is the thickness of the type through the vertical axis of the letter.—"Line" is said to be kept when each letter in a fount has its base at one distance from the upper side of the "body."—"Height-to-paper" is the length from the face of the letter to the foot of the type.

a, *b*, in both figs. being the two halves of the mould, when *a*, *b*, are close and firmly pressed together, the matrix being in its proper place, the type E is cast true, fig. 1. But should any obstruction, as *x* fig. 2, interpose between *a b*, "body" will certainly, and "line" will be generally, wrong, and the type cast will be useless for printing purposes. Workmen depend on hearing or touch to decide whether the mould be clean and tightly closed; an exceedingly small particle of metal or dirt is sufficient to render "body," and in most cases "line," untrue. It is therefore evident, that if a mould similar to this be used, good type cannot be produced unless the intelligence be present; moreover, this hand-casting is very expensive; an average workman being able to cast only about four thousand types per diem. These, we are informed, are paid for at the average rate of elevenpence and a small fraction a thousand.

We have just seen the type metal, and the machine for type-casting, invented and patented by Mr. Johnson. This metal is much harder than any we have seen before, and it appears that it has been put to the severest tests by several large printing establishments, here and abroad, with most satisfactory results. We would recommend such of our readers as are interested or curious in these matters, to go to Liquorpond-street and see the machine for themselves.

The inventor has entirely rejected the hand-mould as a pattern, or necessity. Upon a plain iron table he has firmly fixed the two sides of his mould, which form the "body" of the letter, thus securing the perfect identity in that most important dimension of all type cast; between these two fixed sides works, vertically, the "body-piece;" over all works, horizontally, the "covering-piece;" the matrix is fixed in a little frame and works in a horizontal plane directly to and from the one end of the mould; opposite to the matrix is an orifice through which a jet of liquid metal can be forced by a pump working in a basin or pot of metal melted by a gas-furnace underneath. The type are cast thus:—By means of properly regulated cambs and levers, all turned by one small spindle, the covering-piece advances; the matrix is thrust forward against the end of the mould, forced endwise into its proper place by a spring, clipped between the covering-piece and the ascending body-piece. All being fixed and ready, the pump forces in sufficient metal to form the letter, the matrix is retired, the body-piece rises, forcing up the new-cast type, which the covering-piece, again advancing, drives off on to a moveable platform, where it has time to cool before falling on to the bench. The machine is then ready to repeat the operation. The whole thing is so simple and mechanical, that we believe the question of making type by machinery is solved. A report of the Chamber of Printers of Paris and of the Director of the Imperial Foundry of Paris, together with a letter from Mr. Coombe, relating to the performances of one of these machines erected and driven by steam under his superintendence at the Oxford University Press, agree with our own observation, that at least thirty thousand letters may be easily produced by ten hours' working of one machine. If type can be cast of this material, and at this rate, possessing no unobserved defects, printing will be largely benefitted; especially newspapers and periodicals printed by steam-presses, in which the type is subjected to so great a strain.

By the reduction of cost, this invention will tend to assist the spread of information, and we are therefore glad to aid in bringing it into notice.

A new church has been consecrated at Glanogwen, a village near Penrhyn. The building consists of a nave with clerestory and aisles, a spacious chancel with aisles, south vestry, tower and spire at the west end, and is calculated to hold 700 persons. The style is that of the beginning of the fourteenth century. The walls are built of a greystone found on the spot; the door and window dressings are of Stourbridge stone, of a rich warm colour; the internal stonework is from the Bath stone quarries; the pulpit is of stone panelled and carved; the chancel fittings, lectern, and prayer-desk, of oak; the roofs are of Baltic fir, stained and varnished, the intervals between the rafters being coloured of a rich blue; the stone carving, both internally and externally, is of a very elaborate design, and beautifully executed, under the superintendence of Mr. T. H. Wyatt, the architect. The church is warmed with hot air and lighted with gas. It has been erected at an expense of 6000*l.*, exclusive of the endowment.

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NOTES OF THE MONTH.

At the opening general meeting of the session 1856-7 of the Institute of British Architects, held on the 3rd ult., Mr. William C. Birch, of London, and Mr. R. Lloyd Williams, of Denbigh, were elected associates of the Institute.

The remaining sheets of the Westminster detail survey are lying at the office of the Metropolitan Board of Works, Greek-street, Soho-square. The sheet that joins on to the one issued by the Government to architects, contains the entire detail of the new palace, the Abbey, and Abbey precincts, &c., together with all private property extending some distance up Birdcage-walk. This survey was made in 1849, for the then Commissioners of Sewers.

The long low galleries adjoining the old Elgin gallery, British Museum, which are devoted to the Nineveh collection, are now in progress and nearly completed, and the collections are being arranged.

The executive committee of the Conservative Land Society have taken measures for the construction of a new foot-bridge across the Thames, at Richmond, as an appendage to the present railway-bridge, and a direct communication between Richmond, Isleworth, and the society's property at St. Margaret's. Mr. George Morgan, the architect and surveyor to the society, has prepared a plan, with access to the Middlesex and Surrey ends by light spiral staircases, without injuring the design of Mr. Pennethorne. The project has received the sanction of the South-Western Railway Company, and of the corporation of London as conservators of the Thames. It now requires the assent of the Woods and Forests, as the spiral staircase on the Surrey side would touch the property of the Crown.

A massive scaffolding in the vestibule of the Post Office, St. Martin's-le-Grand, has been raised in order to replace the roof with one of glass. Other alterations are in progress to remove the entire receiving-department to the south wing.

A statue to the memory of the founder of the Foundling Hospital, Captain Coram, has just been placed on the stone structure in the centre of the entrance-gates of the building. The figure, which admirably represents the philanthropist as handed down to us by Hogarth, is 8 feet high; it is satisfactorily executed in Caen stone.

The foundation stone of a new church, dedicated to St. John, has been laid recently at Barnsley. The site of the edifice is called Barebones, a piece of high ground which commands a most extensive prospect, and the edifice, when completed, will be seen, and form a most conspicuous object in the landscape for a circuit of many miles. The church is designed in the early Decorated style of architecture, and will consist of chancel, 31 feet by 18, with sacristy in the north side; a clerestoried nave of five bays, 75 feet by 21 feet, having north and south aisles 9 feet in width. The total internal width of the church will be 45 feet, and the total length 106 feet. The body of the nave to the apex of the roof will be 56 feet, consisting of very strongly braced and bolted principal framing (no intermediates will be used) and common rafters, and will be open to the ridge. The roof over the chancel is high, pitched, and divided into panels, formed by boldly moulded ribs. The pulpit will be on the north-east angle of the nave, and, with all the other fittings, will be executed in red (stained) deal. The walls will be built with pitched-face sandstone, from the adjoining quarry. The whole of the walls will be diapered on the interior of the building, and will be made by means of simple polychromatic decorations, to look as cheerful and light as possible. The estimated cost of the building is 2000*l*.

Considerable improvements are about to be made in the parish church of Silkstone. The unsightly galleries are to be removed, and a new roof put upon the body of the church. The outlay will be upwards of 2000*l*.

Cheltenham has struck a medal in commemoration of the visit to that town of the members of the British Association.

The Keyham tunnel at Devonport, which is being executed by Mr. Smith, of London, contractor, is now drawing near completion. A passage has been effected between Keyham and the dockyard. The length of the tunnel is nearly three-quarters of a mile: it passes under Moon-street, Morice Town, continuing its course under the gun-wharf to the dockyard, at a level above the elevation of the highest spring tides.

Recent experiments made in France upon the new metal aluminium prove that to unite it with other metals deprives it of some one or other of its peculiar qualities. Thus, copper or iron mixed with it in the proportion of one-twentieth, deprives it of its malleability to such an extent as to render it almost impossible to work it; a tenth of copper renders it as brittle as glass, and subject to get black in the air; and gold and silver have also a bad effect on it, though in less degree.

Dr. Lover, the eminent lecturer on natural philosophy, states that the oxydate lamp, invented by Mr. Nibbs, of Bakewell, gives forth such a pure and steady light from a very thin and perfectly white sheet of flame, that it is applicable to the copying of collodion photographs by night, and is also well suited to the microscope.

Mr. Dods, of the Vulcan Foundry, Warrington, is building for the Vale of Neath, under the directions of Mr. Brunel, tank engines, which, when completed, will weigh 42 tons gross with fuel and water, with 24-in. stroke and six 5-ft. coupled wheels. The tank is placed saddle-back fashion, and to contain 1500 gallons. They are designed to work the heavy goods train on that line.

A bridge, just erected over the Tees at Dinsdale, near Darlington, fell recently, while the men were removing the centres from the arches. Two of the men were killed, and several were severely injured. The bridge was being erected on old stone buttresses, turning upon them four brick arches, three spanning the river, and one land arch on the Durham side, varying from 45 feet to 48 feet span. When the arches gave way, nothing remained but the land arch and the stone buttresses.

Among the more recent improvements adopted by the London and North-Western Company for securing perfect safety of travelling over their line, has been the establishment of a "special train telegraph," with signal stations every two miles. At each station a policeman is on duty night and day, in whose watch-box there is a telegraph dial with a single needle. By inclining the needle to the left hand, the person in charge gives notice to the next station that a train had passed on to the two miles of the road entrusted to his special care; while inclining it to the right hand would show that the train had passed off that portion of the line. There were in fact but two signals, "train on" and "train off," but as it might happen that an accident occurred upon the two miles of road between the telegraph stations, the guard and breaksman were instructed instantly to sever the "special train wire," which has the effect of placing the needle at each adjacent station in an upright position. The policeman on duty at once becomes aware by this movement that something is wrong, and can act according to circumstances.

Mr. Hemans, civil engineer, has been appointed to survey a new line of railway from Goragh Wood to Armagh, Ireland.

Mr. Morrison, of Newcastle-on-Tyne, lately read a paper at the Institution of Mechanical Engineers, Birmingham, on an improved Steam Pile-Driver. The machine consists of a steam cylinder and piston, carried on an upright frame-work; the piston-rod itself, being very large in diameter and of great length, acts as the hammer to drive the piles, being raised by the steam in the cylinder and then let fall on the top of the pile. The cylinder rests on the top of the pile, so as to descend with it, the whole weight being borne by the pile. The slide valve for admitting the steam below the piston to raise the hammer is worked by means of self-acting gearing. When the pile is driven, the cylinder is raised again by a chain wound on the barrel of a small steam-engine, which is also used for raising and placing the piles; and the whole machine, with the steam-boiler and engine, is carried on a framework on wheels, which runs along on the top of the piles already driven, as the work progresses, without requiring any additional framing to support it. A double pile-driver of this description, having two cylinders, for driving a pair of piles at the same time, has been employed with great advantage near Newcastle, driving a number of piles in one day, and effecting a great saving in labour and expense.

M. Deloigne, of Paris, has brought forward an invention, the object of which is to avoid the injurious effects to ships, gun-boats, and rafts, arising from the recoil of heavy mortars, or pieces of ordnance, fired at a considerable angle of inclination, and the invention consists in forming a well through the boat or raft, in which well the ordnance piece is to be mounted, so that the water shall receive the recoil. In this well a watertight cylinder, somewhat smaller in diameter than the well itself, is

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placed. The cylinder is supported in the well by vulcanised india-rubber or other springs, and is free to move up and down between guides. Its bottom is formed by the breech plate of the gun or mortar, which is constructed in the manner generally understood. The bottom of the cylinder is, by preference, made to be below the line of flotation, so as to be constantly surrounded by water inside the well. Or, instead of causing the breech to act direct, and making a well in the boat, a strong rod running through the boat, supporting the gun at its upper end, and having a suitable plate at its lower end in the water, with suitable spring to keep the upper end tightly against the breech of the mortar, may be made to serve as intermediate between the gun and water, or other analogous means may be used.

Some more exact details have been received with regard to the Russian railway concession. The roads are to be finished in 10 years, and the duration of the concession is to be for 85 years from the time each line is completed. The lines to be constructed are:—1. The Warsaw line; 2. Kovno, to the Prussian frontier; 3. Moscow to Nigny Novgorod; 4. Moscow to Theodosia; 5. Malo Archangelsk to Libau. The Government guarantee 5 per cent, including sinking fund, which, however, it is reported, is not to commence for 30 years, when it will be at the rate of one-half per cent. per annum. Twenty years after the opening of each line the Government are to have the right of purchase by allowing for 65 years a sum per annum equal to the average profits of the last five years. During next year and 1858 about 200 English miles are to be opened, in the five following years about 470 miles, and in the last three years the whole of the remainder. The distance from Theodosia to Moscow is to be performed in two days.

The Emperor Alexander has presented Mr. John Head (eldest son of Jeremiah Head, Esq., of Ipswich), the chief engineer of the waterworks in Warsaw, with a magnificent gold ring set with eight diamonds of the finest water.

A subscription list of 100,000*l.*, has just been completed in London towards the construction of a railway, twenty miles in length, by the side of the Welland Canal, connecting Lake Erie with Lake Ontario. The total cost of the line is to be about 175,000*l.*

Mr. William Lousdell, of Memphis, Tenessee, has invented what he terms a marine locomotive, and which is designed to be substituted for the present steam water-craft, by making the base of the boat the propelling agent, instead of paddle-wheels, as now used. The invention consists in using two huge parallel hollow screws in the place of the present keel, and revolving them by means of steam-power, so that they will cut their way through the water, as a common screw cuts into wood. The screws are constructed of iron, and, as before stated, are hollow, but are divided into compartments as a precaution against sinking, in case of accident. The cabin of the locomotive will be constructed on frame-work, elevated above these screws, and will altogether be more pleasantly situated than the cabins of our river-steamers, admitting the passage of fresh air beneath its whole length and breadth. It is believed, that when fairly put upon the water, and under advantageous circumstances, the locomotive can make about thirty miles an hour, and thus compete with our railroad trains in speed as well as safety. The model has been put upon trial, and has performed very satisfactorily.

It is stated that on the Housatonic Railroad, U.S. America, a year ago, the journal-boxes of a railway carriage were packed with slices of fresh pork. It was once or twice opened and found in good condition. It has been running regularly ever since. The wheels are perfectly clean, run very easily, and the pork, during warm weather, emitted no disagreeable smell. It is spoken of as a very important item in railway economy.

The first meeting of the Cambridge Architectural Society for the term was held on Wednesday, October 29th. In the absence of the president, the chair was taken by the Rev. W. M. Campion, of Queen's College. The Secretary read a paper on the Church of the Holy Spirit, at Wisby, in Gottland. The paper was illustrated by a series of lithographs, drawn by a Danish architect. The church is of a peculiar construction, being an octagon of two stories with an octagonal aperture in the roof of the lower church, opening to that above. Its date is about 1200 A.D. The Rev. G. Williams, of King's College, then gave a short account of the progress of Church Restoration in Germany, particularly with reference to the Cathedral of Cologne, and the Church of St. Gereon, in the same city.

OBITUARY.

Recently, at Long-island, U.S. (America), Mr. George Steers, the eminent marine architect, the projector of a new system of marine architecture, based upon the assumption that for a vessel to sail easily, steadily, and rapidly, the displacement of water must be nearly uniform along the lines. He was the builder of the celebrated yacht *America*, and more recently, among many other achievements, of the steam frigate *Niagara*, for the American government, and the "Collins" steam ship *Adriatic*.

Lately, Messrs. George Porter and Robert Reid, Fellows, R.I.B.A.

COMPETITIONS.

The Trustees for sale of a Freehold Estate of 500 acres, including the Beulah Spa, and near the Crystal Palace, require Plans for Laying Out the same for building purposes, showing the necessary roads, sewers, &c., the whole to be clearly defined and apportioned in suitable lots, and laid down to a scale of two chains to one inch, from actual admeasurement. The premiums offered are, for the approved plan, 150 guineas; for the second, 100 guineas; for the third, 50 guineas. Particulars may be obtained of Mr. Peacock, builder, near the Jolly Sailor Station, Norwood. The plans are to be forwarded to the Secretary's office, Auction Mart, London, addressed to the Trustees of the White Horse, Norwood Estate. The time for receiving them is extended to the 8th of December.

The St James's Church Building Committee, Southampton, are desirous of receiving plans, detailed drawings, and specifications for the erection of St. James's Church, Southampton, on or before the 18th of December next. The church to contain 750 sittings, including 150 children, at a cost not exceeding 3500*l.* to be completed with tower and spire, exclusive of lighting and warming; but a separate estimate will be required for the tower and spire, to enable the committee to erect the same now or at a future period. The sum of 50*l.* will be paid for the plans, drawings, and specifications retained. The plans to be sent to the Rev. W. White, 12, Laura-place, Southampton.

The Corporation of Sandwich are about to erect a New Swing Bridge over the river Stour, at Sandwich, Kent, in place of the old bridge. Plans and Estimates are invited for the bridge, either of iron or wood—the estimate to cover the total cost of fixing the new bridge complete for traffic. Plans, &c., are to be sent in to the Town-clerk by the 15th day of December.

A Premium of 100*l.* is offered for the best Essay on the present condition and future prospects of Canals and Canal Conveyance. Essays to be sent in to Mr. Thomas Wilson, Honorary Secretary to the Canal Association, Aire and Calder Navigation Office, Leeds, to December 31.

The Directors of the Berwick Corn Exchange Company invite Architects to furnish Designs for a New Corn Exchange, with Committee Rooms, &c. for the town of Berwick. Sketches of ground-plan and other particulars may be obtained from Mr. Stephen Sanderson, Secretary. There will be awarded for the design adopted, 40*l.*; and for the design next most approved of, 15*l.* Designs must be sent in by the 1st of January.

The Committee for carrying out the erection of the Memorial Church at Constantinople, wish to receive designs for the same. The style to be adopted must be a modification to suit the climate, of the "Pointed" or Gothic. The church to be of sufficient capacity to hold, without galleries, seven hundred persons, and the cost not to exceed 20,000*l.* Premiums, 100*l.* for the first, and 70*l.* and 50*l.* for the second and third, or in case of equality, two prizes of 50*l.* The Designs to be sent to the Honorary Secretaries of the Memorial Church, No. 79, Pall-mall, not later than January 1st, 1857.

Designs are wanted for a New Town-hall, to be erected in St. Andrew's—the cost of erection not to exceed 3500*l.* Particulars may be had of Messrs. Grace and Yoole, Town-clerks, St. Andrew's, Scotland.

The Commissioners of Her Majesty's Works and Public Buildings invite architects of all countries to furnish them with designs for Offices for the Secretary of State for Foreign Affairs, for the Secretary of State for War, and for laying out the ground between the Thames and St. James's-park, adjoining Great George-street. The drawings to be made to a scale of 16 feet to the inch. General specifications of the materials proposed to be used in the buildings must accompany each design. A block-plan showing how the site may be so appropriated that the two buildings proposed to be erected may form part of a large and comprehensive scheme for concentrating the principal public offices, and for the improvement of the leading thoroughfares, including Westminster-bridge, whether as regards its present or any other site. Seven premiums for the best designs for the War Office of 800*l.*, 500*l.*, 300*l.*, 200*l.*, 100*l.*, 100*l.*, and 100*l.* Seven premiums for the best designs for the Foreign Office, of 800*l.*, 500*l.*, 300*l.*, 200*l.*, 100*l.*, 100*l.*, and 100*l.* For the best design for a block plan, three premiums of 500*l.*, 200*l.*, 100*l.* Plans of the ground, and other particulars will be forwarded on application to Mr. Alfred Austin, Office of Works, Whitehall. Designs to be sent in by the 20th of March.

Designs are invited from artists of all countries for a Monument to be erected in St. Paul's Cathedral, to the memory of the late Duke of Wellington. The cost, with all expenses, not to exceed 20,000*l.* Premiums of 700*l.*, 500*l.*, 300*l.*, 200*l.*, and five of 100*l.* A ground plan of the cathedral, and the site of the proposed monument, &c., will be forwarded, on application to Mr. Alfred Austin, Office of Works, Whitehall. Designs from artists residing in the United Kingdom to June 1st, 1857, from artists residing abroad to the 25th of the same month.

The design of Mr. T. Oliver, jun., architect, of Sunderland, has been adopted for the new congregational chapel, Blackburn, Lancashire.

The Court of Guardians of Norwich have awarded the first premium of 100*l.* for the best plans for the new workhouse, to the author of the plans with the motto "Humanitas," of which Messrs. Medland and Maberley, 10, Buckingham-street, Adelphi, were ascertained to be the authors. The second premium of 50*l.* was awarded to the author of the plans having the motto "Eligo," of which the author is Mr. G. R. Nicholls, West Bromwich, near Walsall, Staffordshire.

The designs of Pritchard and Sons have been selected for the new Independent Chapel at Weston-Super-Mare. The design is one of a very elegant Gothic character, having a handsome spire, and calculated to seat from 500 to 600 persons, with school-rooms, &c.

The designs of Messrs. Poulton and Woodman have been selected by the Aylesbury Cemetery Board. The buildings are to be in the decorated Gothic style, and the estimated cost is 1800*l.*

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INSTITUTION OF CIVIL ENGINEERS.

Premiums for Session 1855-56.

1. Telford Medal, and a Council Premium of Books, suitably bound and inscribed, to John Murray, M. Inst. C.E., for his paper "On the Progressive Construction of the Sunderland Docks."
2. Telford Medal, to John Mortimer Heppel, M. Inst. C.E.; for his paper "On the relative proportions of the top, bottom, and middle webs of Iron Girders and Tubes."
3. Telford Medal, to Henry Robinson, Assoc. Inst. C.E., for his paper "On the Past and present Condition of the River Thames."
4. Telford Medal, to Charles Robert Drysdale, Assoc. Inst. C. E., for his paper "On Steep Gradients of Railways, and the Locomotives employed.
5. Telford Medal, to Frederick M. Kelley (New York, U.S. America), for his paper "On the Junction of the Atlantic and Pacific Oceans, and the practicability of a Ship Canal, without Locks, by the valley of the Atrato."
6. Council Premium of Books, suitably bound and inscribed, to George Herbert, for his paper "On the Construction of Buoys, Beacons, and other Stationary Floating Bodies."
7. Council Premium of Books, suitably bound and inscribed, to Evan Hopkins, for his paper "On the Vertical Structure of Primary Rocks, and the general character of their Gold-bearing Varieties."
8. Council Premium of Books, suitably bound and inscribed, to William Heinke, for his paper "On Improvements in Diving Dresses and other Apparatus for working under Water."
9. Council Premium of Books, suitably bound and inscribed, to John Baillie (Vienna), for his paper "On the Application of Volute Springs to the Safety-valves of locomotive and other boilers."
10. Council Premium of Books, suitably bound and inscribed, to William Kemble Hall (U.S. America), for his paper "On the Causes of the Explosions of Steam Boilers."

Nov. 11.—ROBERT STEPHENSON, M.P., President, in the Chair.

Nov. 18.—G. P. BIDDER, Vice-President, in the Chair.

On taking the Chair the President said, that for some time past the state of his health had been so precarious, as to render it doubtful whether he could remain in England to be present at the first meeting of the Session; he had been extremely anxious on this point, as he wished to meet the Members before his departure on a journey which might have a duration of at least two months, and thus cause his absence at the period of the Annual General Meeting, when the election of the Council and Officers for the ensuing year would take place. It would be remembered, that in his inaugural address he had thus stated his views as to the duration of the tenure of the office of President: "Referring to matters peculiar to the Institution, it is my duty, before I conclude, to mention a subject which has occupied the serious attention of your Council,—I mean the duration of the tenure of the office of President. My individual opinion of the question has been already expressed in this room, and those sentiments have undergone no change. My mission is now, however, to represent the views of the collective body, and to conform to any course which may be deemed for the general good." Still retaining these sentiments, he had been desirous of retiring at the expiration of the first year of office, but it had been represented to him that such a step might be prejudicial to the welfare of the Institution. That consideration, combined with the persuasions of the kind friends around him, induced him to abandon his previous determination, and to leave the matter in the hands of the general body; therefore, if at the period of the election he was again honoured by the suffrages of the Members, he should be happy to continue to preside over the Institution; but, on the other hand, if he was permitted to retire among the ranks of the Past Presidents, he should still hope to be constant in his attendance at the meetings and to take an active part in the proceedings, which he considered was an imperative duty imposed on those who had been honoured by election to the presidential chair.

He begged to thank all those gentlemen who had contributed Papers during the past year, and expressed a hope that they would be fully emulated during the present session. It would, perhaps, be invidious to allude to any particular Papers, but he must, nevertheless, mention Mr. Murray's excellent Account of Sunderland Docks, as deserving the careful study of all the junior members of the profession; it was replete with useful information, giving practical details of a large work which had been more than usually successful, and as an example of Dock Engineering stood almost unrivalled in this country. The system of sluicing, or scouring of the entrance, particularly deserved attention, as the volumes of water simultaneously emitted from numerous apertures, by means of Armstrong's hydraulic apparatus, possessed an almost irresistible force sufficing for the removal of all the accumulation of salt, sand, and debris brought by storms, or deposit within the entrance channel. This mode of the application of water-power was about to be adopted in other positions with, he hoped, equal success.

He could not avoid also mentioning another Paper, for which he felt under peculiar obligation, as it was produced almost entirely at his personal request. He alluded to the Explanation of the System of Mental Calculation which had been given by his friend Mr. Bidder, to whom he tendered his best thanks. The subject was one in which Mr. Bidder stood pre-eminent; but however rapidly the results might be arrived at, yet it was by no means so easy to explain the processes. Several weeks had been devoted to the preparation of the lectures, in order to give the explanation in simple terms; but it had required much greater time and attention to reduce them to writing for publication. The difficulties, had, however, been, to a great extent, overcome; the whole is now in type, and the concluding part of the volume of the Proceedings of the past year was now nearly ready for being issued.

After the reading of the Paper "On the Improvement of Railway Locomotive Stock," by Mr. D. K. Clark, Assoc. Inst. C.E., which had been previously printed and circulated,* a communication was brought forward, claiming for Mr. James Kennedy, of Liverpool, the merit of having first introduced a locomotive with horizontal cylinders and a cranked axle, inasmuch as it was asserted that they were first applied by Mr. Kennedy in the "Liverpool," which was stated to have been started on the 22nd July, 1830, and was employed in aiding in the construction of the Liverpool and Manchester Railway. That engine was said to have frequently run, with a load, at the rate of 58 miles per hour. The wheels were 6 feet in diameter, and there was a dome for a steam chamber. The principle of the "Liverpool" was stated to have been followed in the "Planet," which had four wheels, and inside cylinders, as first adopted by Messrs. Stephenson, and also in the "Globe," built for the Stockton and Darlington Railway by Mr. Hackworth.

It was explained, that the boiler of the "Liverpool" had a number of convoluted flues; that the fire was urged by bellows, without the aid of the blast pipe; that the engineer managed the engine at one end, and the stoker fired at the other extremity; that the speed attained never reached anything like 58 miles per hour; and that as it had been built on speculation, after it had been tried on the Liverpool and Manchester Railway, with but indifferent success, the Directors declined to become purchasers. It was then tried upon the Bolton line, and after the substitution of a new multitubular boiler, with the blast pipe, and undergoing a thorough renovation, it was ultimately purchased by Mr. Hargreaves for the Bolton line. It was never considered the type for the class of engines used on the Liverpool and Manchester line. The horizontal cylinders and cranked axles had been commonly employed long previously, in Trevithick's, Gurney's, and almost all the other locomotives for turnpike roads, and the statements alleged to have been made by the late Mr. George Stephenson, as to the priority of the peculiar arrangement of the "Liverpool," were asserted to be erroneous. It is well known, that the "Planet," which was admitted to be the type of the engines employed on the line, was designed by Mr. Robert Stephenson; and the working drawings had been made and the engine constructed under his direction, without any reference to or knowledge of the "Liverpool." These facts are fully confirmed by those who were confidentially employed upon the engine at Messrs. Stephenson's works at the time. There was not any analogy between the two machines, as the "Planet" had a multitubular boiler, the fire being urged by a blast pipe, and the cylinders, which were as nearly horizontal as their position would permit, were fixed inside, or between the frames, because it was only by such an arrangement that they could be placed within the smoke-box, where it was considered desirable to fix them, in order to prevent the condensation of the steam in the cylinders, and the consequent loss of power. This determination had arisen from information given to Mr. R. Stephenson by the late Mr. Trevithick, who, in the course of some experiments upon the engine at the Dolcoath mine, had built a brick flue around the cylinder, and had applied the heat of a fire directly to the metal, with very beneficial results, as regarded the economical use of steam. With the cylinders in the smoke-box, a cranked axle was indispensable, and there was not anything new in its use in locomotives, for the "Novelty" had one in 1829.

It further appeared, from the delivery-journal kept at Messrs. Stephenson's manufactory at Newcastle, that the "Planet" was charged to the Liverpool and Manchester Railway Company on the 3rd of September, 1830; that the minute-book of the board of directors of that line contained a record of the arrival of the "Planet" being reported to the board, at their meeting on the 4th of October, 1830; and that three weeks afterwards, at their meeting on the 25th of October, the "Liverpool" was reported to the board to be ready for trial.

Since the Paper was written the process of equilibrating the engines had been extensively applied on the South-Western Railway, producing an economy of fuel of nearly 11 per cent. Two passenger engines on the Cork and Bandon Railway had been equilibrated with the like benefit. On the same class of trains, the consumption of fuel before and after equilibration, was stated to be at the rates of 26 lb. and 22 lb per mile, with trains consisting respectively of 8 and 10 carriages; showing a saving of at least 15 per cent. of fuel. It appeared from recent statements, that in America, an economy of nearly 25 per cent. was obtained by heating the feed-water. Returns from twenty-two superintendents

* See *Journal*, *ante* p. 249.

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of locomotives on British railways showed, that in June 1856, the cost of railway coke was 18*s.* 2*d.* per ton, whilst that of coal used in locomotives was only 8*s.* 7*d.* per ton, and if, as had been stated, the effect produced was weight for weight the same, the economy would be upwards of 50 per cent.

A comparison of the results of the performances of five engines burning coke, and five burning coal, on the main line of the London and South-Western Railway between London and Southampton and back, showed an average consumption of coke per mile of 20·7 lb. with 10·4 carriages per train, against a consumption of coal of 18·9 lb. per mile, with 12·2 carriages per train. From this it would be seen, that there was a saving of 8½ per cent. in consumption of fuel in favour of coal, whilst the number of carriages per train was 14¾ per cent. greater. The average cost of coke was 27*s.* 6*d.* per ton, and of coal 18*s.* 6*d.* per ton, giving a cost per mile of 3·04*d.* per mile in the former case, and of 1·87*d.* per mile in the latter, or a saving of 1·17*d.* per mile with trains 14¾ per cent. heavier; but notwithstanding this, the saving of fuel amounted to 38 per cent., and if the loads had been equal, then the saving would have amounted to 46½ per cent.

It was stated, that on the Shrewsbury and Hereford Railway, the results of burning all coal in the passenger engines—in place of half coal and half coke—taking the price of coke at 20*s.* and of coal at 11*s.* per ton, was a saving of 0·69*d.* per mile. These engines when burning only coke could never be got below 18½ lb. per mile, whereas now they only burn 18·9 lb. of coal, with the same average load, and running at the same speeds. With the four-wheeled coupled goods engine, there was a saving of 2·05*d.* per mile in the cost of fuel by burning all coal, instead of one-third coal and two-thirds coke, with an average load of 168 tons in both cases. With the six-wheeled coupled goods engines, under similar conditions, the saving was 2·69*d.* per mile, with an average load of 188 tons. There was no difficulty in getting up steam, and there was a complete absence of all nuisance from smoke, which hitherto had been the chief difficulty to be overcome in the use of coal in locomotives. It was explained that the fire-bars, which were very thin, so as to allow of the free passage of air, were placed in a rocking frame, by which the level could be varied, according to the condition of the fire, and the work to be performed demanded.

On the Northern of France Line, scarcely any other fuel than coal was now burned, and the economy resulting was fully one-third in money value. It should be stated however, that the coal used was the dry semi-bituminous coal of the Mons Colleries, which was of excellent quality, whereas the coke was not good. The saving of 15 per cent. arising from the heating of the feed-water, was admitted. It would, however, have been more conclusive to have tried coal and coke alternately in the same engine. The apparatus used in France was very simple, being merely a horizontal arrangement of the fire-bars, which were placed transversely, and in steps across the fire-box, so as to have wide air spaces, without risk of losing the fuel through the spaces.

In answer to questions, it was stated, that the boilers of the South Western coal-burning engines were only a very little more expensive than ordinary boilers, and there did not at present, after very heavy running, appear to be any evidence of more rapid destruction of tubes, or of fire-boxes, than when burning coke. Indeed, there was reason to apprehend, that the particles of coal in combustion would do less mechanical injury to the tubes than the bits of hard coke rapidly travelling through.

Thin and careful firing was recommended, and with that there was no reason why the same results should not be obtained in the locomotive boiler with coal, as in a stationary boiler, under which coke would never be considered necessary.

It was generally admitted, that there was an entire absence of smoke in the engines of the South-Western Line, which was not the case on several other lines where the system had been tried—yet bituminous coking coal had been tried, with the same good results. It was evident then, that the fire-tiles had considerable influence in producing that effect, as well as in enabling the engines to run home light, with scarcely any expenditure of fuel; the heat previously absorbed by the fire-tiles, being given out again when required, and thus keeping up the steam.

Reference was made to a discussion at the Institution in 1839, where it was stated, that "to say that the 15 cwt. of coke, produced from a ton of coal, was equal in heating powers to the original ton, was to say that there were no heating powers to be derived from the 9 or 10,000 cubic feet of gas produced, or the 10 gallons of tar." Now it was possible that, in the arrangement of his boiler, Mr. Beattie had just arrived at the rate of combustion, and mode of employing the fuel, to take the utmost advantage of the whole of the carbonaceous matter, and all the inflammable gases contained in the fuel; if this were true, the progress was one of the most remarkable steps towards perfecting the locomotive engine.

In summing up the discussion, it was observed, that although the subject had been treated with great ability by Mr. Clark, and the documentary evidence brought forward during the discussion, was very conclusive in favour of the system, which, indeed, appeared to be generally admitted as a great and economical improvement, yet there still remained much to be done, practically, and to be described to the Institution. There were still several important discrepancies to be cleared up; and, at this moment, when, for example, in India it would be most important to burn only coal, as indeed had been done on the East India Railway for some time, the best methods were most desirable to be attained, and the descriptions should emanate from the Institution. The equilibrating of engines had been extensively and beneficially practised by Mr. J. V. Gooch on the Eastern Counties Line, and on the system there was much to be learned and to be communicated to the Institution.

Nov. 25.—I. K. BRUNEL, Vice-President, in the Chair.

In consequence of the decease of Mr. Rendel, a proposition for the adjournment of the meeting, as a mark of respect for the memory of the late distinguished member, was unanimously agreed to.

SCULPTURE MODELLING IN PLASTER OF PARIS.

Mr. J. Knowles, jun., of Raymond-buildings, Gray's Inn, in a letter to the *Athenæum* says:—Mr. Powers' process of sculpture modelling in plaster of Paris was most courteously explained to me in a detailed manner by himself, at Florence, in the year before last. He reverts to literal sculpture, manufacturing in the first place a block of sulphate of lime (bounded merely by the rough outlines of his intended statue), which he then cuts down, by means of hatchets and chisels, to the more accurate figure, and finishes by means of spuds and files of his own invention.

The original block is constructed in a masonry of small bricks of "gesso," laid in plaster, and of dimensions varying from three to four inches long by two to two-and-a-half inches wide, and about three-quarters to one inch thick. These, piled together, become a homogeneous mass of sulphate of lime, and an easily workable artificial stone. The block so made is next chipped down to the required size, the component limbs and trunk being hewn out of the solid, principally by the aid of small and light chisels and hammers. Upon the scaly chipped surface of the figure in this state (when it resembles a lepidodendron more than anything else), the modelling of the muscles and features is effected in a paste of plaster, dabbed on with trowels, floats, and finally spuds of various sizes. The finished surface of the nude is lastly worked up by hollow files, pierced at one end, like a colander, with holes, half round which a tooth is raised. These files are extremely effective; they are made by the artist himself, of every shape, size, and curvature, and rasp the dry plaster away beautifully, leaving a pleasant texture of surface. With great kindness Mr. Powers explained their usefulness to an architect for making building models,—and authorised me, as a brother-in-craft, to make any use of their principle, although patented, that I might find architecturally valuable.

In the fingers and extremities of the plaster model, copper wires are inserted, being the only representatives of the unwieldly mass of iron frame-work necessary for the setting up and support of a clay model; and these wires by their ductility, afford sufficient liberty for changing the pose and attitude of members, if, as the work proceeds, occasion arises for so doing. A finger, for instance, requires to be more bent;—it is sawn through to the wire at the joint, the wire is twisted into the required position, and a fresh modelling of the joint-muscles is alone required. The wires, in fact, take the place of bones.

For finishing the limbs of his figures with that extreme nicety which he does, Mr. Powers adopts a bold and novel mode. He has invented a vice,—which is set upon a ball-and-socket joint,—and has, by virtue of raising and depressing screws, every possible variety of motion. This instrument is the perfection of ingenuity. The sculptor cuts off from his figure an arm, a head, a leg, when modelled sufficiently for his purpose, and, fixing it in the vice, turns, twists, scrapes and polishes it at his ease, to the most detailed finish. In cutting off, a dowel is inserted into one side of the cut, and a mortice-hole left in the other,—and these are so arranged, with regard to a groove which is first made on the outside of the limb, as to insure an absolute accuracy in refitting. By arrangements of this kind the working of the torso is rendered much less difficult than when covered in part by limbs stretching before it,—and the finishing of the nude to that exactness which Mr. Powers always adopts before touching the drapery, becomes a less tedious operation.

The several advantages obtained by his system Mr. Powers explained to be—the saving of one whole operation, viz., casting, the model itself being used for the points; the convenience of being able at any time to put aside or resume a study without that intervening watchfulness, and care in moistening and covering up, which a clay model requires; the more absolutely sculpturesque nature of the designing itself; the facility of bending the extremities when modelled by means of their central wiry bones, which would only cut through instead of moving the clayey limbs; the saving of time and labour, by remodelling a portion only, instead of a whole limb, when slightly altered in position; and, lastly, the better anatomical exactitude with which members detached from the body may, as members, be worked.

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NEW PATENTS.

PROVISIONAL PROTECTIONS GRANTED UNDER THE PATENT LAWS AMENDMENT ACT.

Dated July 15.

1664. A. Nefld, Manchester — Improvements in jacquard and other pattern looms. (Communication)

Dated August 1.

1822. J. Avery, Essex-street, Strand—Improvements in bonnets and other coverings for the head (Communication)

Dated August 6.

1858. J. Braby, Borough Haymarket, Newington-causeway—Improvements in sawing machinery

Dated September 3.

2041. J. B. M. Jobard, Brussels—Improvements in the manufacture of lamps

Dated September 13.

2145. J. H. Johnson, Lincoln's-inn-fields— Improvements in fire-arms. (Communication)

Dated September 15.

2152. F. Moreau, South-street, Finsbury—Improvements applicable to the tops of omnibuses and other carriages

Dated September 17.

2178. A. L. Newman, New Church-street, Bermondsey—Improvements in processes for separating animal from vegetable fibre, and for adapting the products to manufacturing purposes, and in the machinery employed therein

Dated September 19.

2199. A. Hustler, Bradford—Improvements in looms for weaving
2200. A. Templeton, Skinner-street, and J. Lawson, Glasgow—Improvements in the manufacture of pile fabrics
2206. J. Underwood and F. A. Birt, Fish-street-hill—Manufacture of copying inks for printing

Dated September 24.

2234. A. J. B. Lespinasse, Toulouse—Improvements in the means of obtaining motive power

Dated September 25.

2246. H. J. M. E. Silvy and A. A. H. Plagniol, Paris—Improvements in harness

Dated September 27.

2265. D. Law, and J. Inglis, Glasgow—Improvements in moulding or shaping metals

Dated September 29.

2276. R. Boycott, Blaina, Aberystruth—An improved air-door

Dated October 1.

2290. P. A. le Comte de Fontainemoreau, South-street, Finsbury — Improved voltaic battery. (Communication from F. Selmi, Turin)

Dated October 3.

2316. J. Hall, jun., Mount Pleasant, Walmersley, near Bury, Lancaster—Improvements in looms
2321. B. P. Mosqueron, Widow Vilcoq, Essex-street, Strand—Improved lamp oil

Dated October 6.

2333. J. Gedge, Wellington-street South—Improvements in the preparation of rocky substances for obtaining mineral manure. (Communication from J. Urfus, Prague)
2335. A. Dunlop, Glasgow—Improvements in dressing or sifting flour or meal
2337. V. Avril, Paris—Improvements in the manufacture of iron and steel, and in the construction of furnaces to be employed therein; also in the obtaining of a certain agent employed in such manufacture

Dated October 7.

2339. T. B. Smith, Taunton, Massachusetts—Improvements in the permanent way of railways, and in the running of railway carriages
2341. W. N. Parsons, Southwark-bridge-road—Improved construction of rotary sawing machine
2343. J. Hinks, Birmingham—New or improved manufacture of metal boxes
2345. W. Wilkinson, Nottingham—Improvements in ornamenting glass, and in the preparation of the materials employed therein
2347. J. A. le Franc, Cecil-street, Strand—Improvement in lubricating oil cans or vessels. (Communication)
2349. W. Marriott and D. Sugden, Huddersfield—Improvement in purifying coal gas

Dated October 8.

2351. J. Chicoso, Camden-town—An apparatus for damping and affixing adhesive stamps and labels
2353. E. Pontifex, Shoe-lane, and G. H. Ogston, Greenwich — Improvements in the manufacture of tartaric and citric acids
2355. J. Leigh, Manchester—The use or application of a certain substance or substances in the manufacture of paper for stiffening or sizing the same
2357. T. Dugdale, jun., Blackburn—Improved lubricator
2359. P. Ward, Liverpool—Improved composition for coating the bottoms of ships
2361. C. Iles, Birmingham—Improvements in frames or stands, and in suspendors, or pegs for holding or suspending hats, coats, and other articles

Dated October 9.

2363. W. S. Clark, High Holborn—Improvements in the construction of churns for producing butter. (Communication)
2365. J. Longridge, Fludyer-street, Westminster, and T. Richardson, Newcastle-on-Tyne—Improvement in constructing the fire-boxes of locomotive steam boilers
2367. C. Burton, Regent-street—Improvements in machinery for washing and cleansing fabrics and cloths
2369. J. B. Howell, Sheffield—Improvements in the manufacture of cast-steel
2370. J. Shaw and E. Shaw, Glossop, Derby—Improvements in pianofortes, organs, harmoniums, and other similar keyed musical instruments
2371. L. Jordan, Berners-street—Medicine for the cure of venereal affections

Dated October 10.

2373. J. Labat, jun., Bordeaux, France—Improvements in closing or stoppering bottles, jars, and other like vessels
2375. C. R. N. Palmer, Southampton—Signalizing apparatus for carriages, and improved telegraph or signal apparatus, applicable to other purposes
2377. W. Johnson, Lincoln's-inn-fields—Improvements in the manufacture of fulminating powder
2379. J. McInnes, Liverpool—An improved surface mineral coating for protecting iron and other substances, and an improved vehicle or varnish by which it is applied, and which varnish may be used with or without the addition of other substances
2381. R. McConnell, and A. Mackenzie, Glasgow—Improvements in supplying steam boilers with water, part of which improvements, or modifications thereof, are applicable for the transmission of fluids and the indication of fluid levels under pressure

Dated October 11.

2383. W. H. Ashburn and J. Fairhurst, Blackburn—Improvements in machinery or apparatus used in the preparation of cotton or other fibrous substances for spinning
2385. A. B. Seichen, Alpha-place, Caledonian-road—Improvements in machinery or apparatus for cutting cork in the process of shaping and making stoppers of cork, and in the treatment of cork to be employed in the said processes, and to be applied to other useful purposes
2387. J. Latham, Liverpool—Registering the number of passengers by omnibuses and other vehicles and conveyances
2389. G. W. Varnell, Camden-town—Improvements in mounting troughs, mangers, and apparatus used for for feeding horses and other animals
2391. L. Ador and E. Abbadie, Paris—Improvements in the manufacture of colours from metals, and in the furnaces or apparatus for the same

Dated October 13.

2393. C. S. John, Barnard's-inn, Holborn—Improvements in machinery or apparatus for preparing pulp suitable for the manufacture of paper
2395. B. Kisch, Kennington—An apparatus for containing an arrangement of cards or papers for selection. (Communication)
2397. G. B. Piatti, Genoa—Improvements in the production of ice
2399. J. Stephens, Glasgow—Improvements in steam boilers and furnaces

Dated October 14.

2401. J. Knowles, jun., St. Helens, Lancaster—Improved apparatus for the prevention of accidents in winding from mines, which apparatus is also applicable for other similar purposes
2403. R. A. Brooman, Fleet-street—An improved method of, and composition for, splitting or rending rock, stone, and earth. (A communication from Martineddu and Co., Marseilles)
2405. T. Allen, Clifton—An improvement in the manufacture of iron and other metallic bedsteads

Dated October 15.

2408. E. Hallen, Cornwall-road, Lambeth—Improvements in the construction of chairs, sofas, bedsteads, and similar articles of furniture to sit or recline upon
2409. J. Burrows, Wigan—An improved arrangement of apparatus employed in winding coals or other minerals from mines, which said improvement is also applicable for other similar purposes
2411. A. Turner and L. Turner, Leicester—An improved manufacture of elastic fabrics
2413. G. Hazeldine, Lant-street, Southwark—Improvements in carriages requiring "poles" between the horses or draught animals

Dated October 16.

2414. G. Collier, Halifax—Improvements in the manufacture of piled fabrics
2415. A. Tooth, Mincing-lane—An improved process for bleaching malt, whereby the colour is rendered more suitable for the brewing of pale or bright malt liquors
2416. C. J. L. Leffler, Old Broad-street—Improved apparatus for the casting of metals
2417. R. F. Sturges, Birmingham—A new or improved manufacture of rollers or cylinders for printing fabrics

Dated October 17.

2418. C. N. Wilcox, Islington—Improvements in the preparation and application of certain vegetable matters to be used in toilette soaps, pomades, and other like perfumery
2419. E. Tombs, Islington—An improvement in screw propelling
2420. J. Commandeur, Lyons—A mechanical apparatus for regenerating the impulsive force of any motive power
2421. F. Foggi, Southampton-place, New-road—Improvements in the manufacture of engines driven by steam or other vapour
2422. J. Green, Charlotte-street, Portland-place—An improved cooking apparatus
2423. E. Rogers, Abercarn, Monmouth—Improvements in apparatus for the decomposition and combustion of fuel
2424. J. E. Reed, Southgate—A mixture or compound for the cure of asthma, consumption, and other affections of the chest or lungs
2425. P. A. le Comte de Fontainemoreau, South-street, Finsbury—Improvements in the construction of turbines. (Communication)
2426. P. A. le Comte de Fontainemoreau, South-street, Finsbury—An improved process for purifying brandies and other alcoholic products. (Communication)
2427. W. Dray, Swan-lane—An improved method of and apparatuses to be employed in the stacking or storing of corn and other agricultural and horticultural produce
2428. G. Wilson, Glasgow—Improvements in power looms
2429. W. Jeffrey, Glasgow—Improvements in machinery or apparatus for sawing or cutting wood
2430. J. McDowall, Johnstone, Renfrew—Improvements in sawing or cutting wood
2431. N. Brecheux, Paris—Improvements in looking glasses applicable especially for dressing rooms and for other purposes
2432. G. Morton, Keighley, York—Improvements in escapements for chronometers and other time-keepers
2433. T. F. Henley, Bromley, Middlesex—The employment of certain substances not hitherto made use of, for the production of alcoholic spirits, and for the manufacturing of the same, the refuse material being applicable as a food for cattle
2434. A. V. Newton, Chancery-lane—Improvements in the manufacture of tufted pile fabrics. (Communication)
2435. W. Gossage, Widnes, Lancaster—Improvements in the manufacture of coal-gas used for illuminating purposes
2436. J. Smith, Kirtley, Suffolk—Improvements in heating the feed-water of steam boilers for marine and land purposes
2437. S. C. Lister and W. Tongue, Bradford—Improvements in spinning
2438. J. R. France, Clarence-street, Islington—Improvements in electric telegraph apparatus
2439. F. A. Magnay, Taverham Mills, near Norwich, and R. B. Whitehead, Saddleworth—Improvements in damping paper for printing
2440. W. Palmer, jun., Sutton-street, Clerkenwell—Improvements in roof saddle-lamps for railway and other carriages
2441. T. Lawes, City-road—An improved construction of agricultural implement to be used in tilling the land

Dated October 18.

2442. R. H. Collyer, Park-road, Regent's-park—Improved method of manufacturing paper
2443. L. J. P. de Mirimonde, Paris—Improvements in reducing the friction of axles and axletrees of carriages on railways
2444. I. Delcambre, Paris—Improvements in machines for composing and distributing type
2445. J. George, South-street, Finsbury—An improved crane.
2446. J. F. Deshayes, Paris—Improvements in machinery for dyeing silk, cotton, or wool in hanks or skeins, or woven fabrics
2447. H. Brown, Halifax—An improvement in spinning worsted
2448. T. Flockton, Trafalgar-square—Improvements in the consumption of smoke
2449. C. Humfrey, The Terrace, Camberwell—Improvements in the manufacture of grease for lubricating railway axles and other machinery

Dated October 20.

2450. J. Harrison, Blackburn—Improvements in machinery for warping yarns, part of which improvements are applicable to creels used for other purposes
2451. F. C. Knowles, Lovell Hill—Improvements in the manufacture of iron and steel, and in the preparation of fuel used therein
2452. R. A. Brooman, Fleet-street—Improvements in farthingales or petticoats. (Communication)
2453. L. P. Huteau, South-street, Finsbury—Improved petticoat
2454. J. Young, South Shields—Improved ventilator

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2455. R. G. Barrow, Wade-street, Poplar—Self-maintaining motive power obtained from water, air, or any other liquid
2456. J. Lacassagne and R. Thiers, Lyons—Improved electric lamp
2457. J. T. Forster, Wandsworth-road—Improvements in the symbols used in signalling
2458. J. G. Jennings, Holland-street, Blackfriars—Improvements in the construction of wall caps, sleeper-blocks for the basements of buildings, and bricks to be used as substitutes for wood bricks in building
2459. C. R. Freeman, Eaton, Norwich, and W. D. Key, Norwich—Improvements in manufacturing food for animals
2460. A. Lorimer, Bedford-square East, Commercial-road—Improvement in re-working vulcanised india-rubber
2461. W. Parsons, Pratt-street, Lambeth—Improvements in generating and employing steam in steam engines
2462. H. Deacon, Hans-place, Chelsea—Improvements in suspending carriage bodies
2463. W. Clay, Liverpool, and J. Harris, Dolgelly, Merionethshire—Improvements in the manufacture of iron and steel

Dated October 21.

2464. C. Briquelet, jun., Rue Emers, Dunkerque, France—The purification, clarification, and discoloration of the cotton-seed oil
2465. H. Thompson, Great Harwood, near Blackburn, and T. Curtis, Blackburn—Improvements in the manufacture of healds or heddles
2466. J. C. Martin, Cottage, Charlewood-road, Putney—An improvement in glazing paper
2467. G. Blair, Leicester—Improvements in the manufacture of looped fabrics
2468. P. A. le Comte de Fontainemoreau, South-street, Finsbury—An improved knitting loom. (Communication)
2469. S. Smith, Soho—Improvements in furnaces
2470. W. Smith, Salisbury-street, Adelphi—Improvement in water level and pressure indicators and lubricators. (Communication)
2471. J. Shaw, Neithrop, Banbury—Improvements in preparing the food of cattle
2472. R. D. Atkinson, Kingston-upon-Hull—Improvements in preparing and coating metallic surfaces. (Communication)
2473. E. O. W. Whitehouse, London, and J. Laws, Brighton—Improvements in tools for soldering metals
2474. G. Thompson, Westbourne-green, Harrow-road—Improvements in machinery for cutting or rending wood for laths and other uses
2475. L. Pattinson, Scots-house, near West Boldon—Improvements in the treatment of certain salts and oxides of manganese
2477. A. V. Newton, Chancery-lane—An improvement applicable to the reefing, furling and unfurling of sails. (Communication)
2478. G. Webster and J. Webster, Fountain-yard, Bridge-end South, Leeds—Improvements in the means of opening and closing the slide valves of engines worked by steam or other power

Dated October 22.

2479. C. H. J. W. M. Liebmann, Fartown, Huddersfield—Improvement in purifying water. (Communication)
2480. G. Erman, Manchester—Improvements in machinery or apparatus for the finishing and treatment of yarns or threads
2481. F. Walton, Haughton Dale Mills, near Denton, Lancaster—Improvements in the manufacture of brushes
2482. G. C. Potts, New Oxford-street—The application of certain materials to the cleaning of casks

Dated October 23.

2483. C. W. Harrison, Woolwich—Improvements in the insulation and protection of electric conductors
2484. T. Gray, Ratcliff Works, Rose-lane, Stepney—An improved drying apparatus
2485. J. F. Porter, Park-street, Westminster—Improvements in the manufacture of bricks and other articles of clay and brick-earth, or of the like materials
2486. G. E. Johns, Falcon-street—The application and adaptation of an optical or stereoscopic arrangement in the manufacture of boxes
2487. J. C. Bremer, Fenchurch-street, London—Improvements in propellers
2488. J. Macdonald, Henry-street, Upper Kennington-lane, Vauxhall—Improvements in regulating the supply of oil or other liquids, applicable to lamps, gas meters, and other useful purposes
2489. N. Brough, Birmingham—Improvements in dress fastenings
2490. A. D. Bishop, Woolwich—Improved apparatus for facilitating the finding and raising of vessels and submerged articles
2491. T. Horrex, South-square, Gray's-inn—Improvements in fastening buttons and other similar articles on to garments and other things
2492. J. Walley, Derby—Improvements in the means of preventing explosions of steam-boilers
2493. J. D. Dunnicliff, Hyson-green, and W. Dexter, Nottingham—Improvements in warp machinery
2494. L. A. Desachy—Improvements in producing architectural mouldings, ornaments, and other works of art formed with surfaces of plaster or cement
2495. E. A. Athawes, Blackfriars-road—An improvement in the construction of forks for forking land

Dated October 24.

2496. J. E. A. Gwynne, Essex Wharf, Essex-street, Strand—Improvements in the manufacture of carbon or charcoal powder for various useful purposes
2497. I. Bailey, Bradford, York—Improvements in machinery for spinning wool, cotton, alpaca, mohair, and other fibrous materials
2498. G. White, Bromley, Middlesex—Improvement in the treatment of grain in order to produce starch and spirit therefrom
2499. R. Brooman, Fleet-street—Improved oil for burning in lamps and an improved burner and chimney. (Communication)
2500. W. Woodford, Taunton, Somerset—The prevention or cure of smoky chimneys.
2501. R. Struthers, Holyhead, Anglesea—Improvements in machinery or apparatus for transmitting motive power
2502. W. Mills, Congreve-street, Birmingham—Improvements in apparatus for cleaning or removing the soot from chimneys
2503. H. Holden, Bingley Hall Works, Birmingham—Improvements in furniture for railway and other carriages, and which said improvements are also applicable as a means of finishing or ornamenting the iron parts of harness and other articles made of iron to which such mode of finish or ornamenting has not heretofore been applied
2504. L. Mangin, South-street, Finsbury—Self-acting door-spring
2505. S. Baxter, Minories—Improvements in chain wheels, or barrels and stoppers to be used for raising and lowering weights by means of chains
2506. C. Anciaume, Quay Bourbon, Paris—Improvements in musical organs, both sedentary and portable

Dated October 25.

2507. G. Ernst, and W. Lorberg, Manchester—Improved mode or method of raising or producing designs, patterns, or impressions on the surfaces of plates, block, or rollers, and transferring or imparting the same to paper, parchment, woven fabrics, leather, or other similar materials
2508. W. Benson, Four Stones, near Hexham, Northumberland—Improvements in apparatus for drying grain, seeds and other substances
2509. C. J. Farrington and W. Comber, Hampstead—Improvements in means or apparatus for giving alarm in case of attempted burglaries
2510. J. Sexton, Leicester-square—Improvements in the construction of caustic holders, applicable also to the holding of leads, chalks, and other marking materials
2511. G. H. Bachhoffner, Upper Montagne-street—Improvements in glass shades for gas and other artificial lights
2513. H. F. Ossman, Essex-street, Strand—Improved contrivance for distending the skirts of ladies' dresses, and preserving the required form and shape thereof. (Communication)
2514. T. Brown, Fenchurch-street,—Improvements in capstans and windlasses

Dated October 27.

2515. B. Ferrey, Trinity-place, Charing-cross—Improvement in producing ornamental plastering or stucco work
2516. J. Birkin, West Bridgeford, Nottingham—Improvements in dressing and cleaning wheat and other grain
2517. H. F. Forbes, Florence, Tuscany—An improved copying press
2519. T. Allan, Adelphi-terrace—Improvements in the permanent way of railways
2521. P. Schäfer and F. Schäfer, Brewer-street—Improved handle for desks, deed and despatch-boxes, bags, furniture, and other articles to which handles are applied
2522. W. E. Newton, Chancery-lane—Improved means of economising the waste heat of furnaces or fireplaces. (Communication)
2523. M. Dognin, Lyons, France—Improvements in machinery for making lace or net

Dated October 28.

2524. W. Brodie, Belhaven, East Lothian—Improvements in the manufacture or production of roofing tiles
2525. E. T. Simpson, Wakefield—Improvements in the manufacture of soap
2526. A. E. Ragon, Bernard-street, Russell-square—Improvements in apparatus for indicating and recording the speed of ships. (Communication from L. Alexandre)
2527. W. S. Losh, Wreay Syke, Cumberland—Improvements in the preparation of size, which may also be used as a waterproof varnish or coating
2528. J. L. Marie, Paris—Improvements in raising, propelling, and forcing water and other fluids, and in obtaining motive power
2529. W. A. Gilbee, South-street, Finsbury—Improvements in the construction of smoke-consuming furnaces. (Communication)
2530. J. Armstrong, Normanton, York—Improvements in the permanent way of railways
2531. S. Russell, Sheaf-gardens, Sheffield—Improvements in the manufacture of teapot handles, knobs, door-plates, finger-plates, razor scales, and knife handles
2532. J. K. Cheetham, Rochdale—Improvements in the manufacture of iron and steel
2533. A. Aubril, Newman-street, Oxford-street—The novel application of a certain root to the manufacture of starch, paper, and cardboard

Dated October 29.

2534. R. Robinson, Eccles New-road, Pendlebury, Lancaster—An improvement or improvements in machinery or apparatus for sizing, dressing, finishing, and polishing yarns or threads
2535. R. Hampton, Rochdale—Improvements in lubricating steam-engines
2536. T. Garnett, Low Moor, Clitheroe—Improvements in the manufacture of paste or size for sizing, stiffening or otherwise preparing cotton and linen yarns and woven fabrics
2537. T. E. Wyche, Camberwell—A method of disengaging metals from the matrix. (Partly a communication)
2538. L. A. Faure, Essex-street, Strand—An improved pump
2539. T. C. Salt, Birmingham—A new or improved method of coating with glass or enamelling surfaces or cast-iron
2540. T. John, Pesth, Hungary—A new electric telegraph apparatus for writing
2541. T. S. Henzell, South Shields—Improvements in the construction of ships or vessels
2542. A. J. Thompson, Birmingham—An improved gum-pot and brush, and which said pot and brush are also applicable for holding and using liquid glue, paste, or other adhesive materials, as well as varnish, paint, and such like fluids, which are licable to dry up by the action of the air.
2543. W. Kopke, Hackney—An improved clasp-board to hold documents for reference.
2544. C. De Jongh, Lautenbach, near Guebwiller, France—An improved method of and machinery for combining and preparing silk, flax, and other fibrous substances
2545. P. Fairbairn, Leeds, and R. Newton, Liverpool—Improvements in machinery for dressing waste silk
2546. F. Whitaker, Canonbury-road, Lower-road, Islington—Improvements in apparatus for supplying water to steam-boilers
2547. J. T. Way, Welbeck-street—Improvements in obtaining light by electricity
2548. D. H. Whittemore, Worcester, Massachusetts—An improved machine for paring, slicing, and coring fruit or vegetables
2549. J. Macallum, Kames Gunpowder Mills, Argyle—Improvements in the preparation or refining of saltpetre

Dated October 30.

2550. W. May, London—Improvement in steam-engine indicators. (Communication)
2551. C. J. B. Torassa, Genoa—An apparatus for calculating the speed of vessels at sea, as well as obtaining the extent of their destination caused by the side winds
2552. H. Holcroft, South-street, Finsbury—An improved steam-engine, specially applicable to agricultural operations
2553. J. Gibbon, Northfleet—Improvements in chaff-cutting machines
2554. J. Simpson and H. Spencer, Rochdale—Improvements in lubricating steam-engines
2555. L. Urion, Nancy, France—Improvements in match boxes or holders

Dated October 31.

2556. C. A. Ferguson, Mill Wall, Poplar—Improvements in preparing timber for ship-building, mast-making, and other purposes
2557. J. Lawson, Morris-place, Glasgow—Improvements in the manufacture of pile and other fabrics
2560. F. C. Matthews, Great Driffield, York—Improvements in preparing manure
2561. S. Worssam, Chelsea, and J. Grist, Islington—Improvements in machinery for cutting and shaping wood
2562. H. Hutton, Reading—Improvements in lubricators

Dated November 1.

2563. E. J. Hughes, Manchester—An improved mode or method of concentrating th colouring matter of certain vegetable substances
2564. J. Browne, Liverpool—Improvements in the construction and working of ships' windlasses and capstans, part of which improvements is also applicable for steering ships and other vessels
2565. P. Smith and T. Irvine, Liverpool—Improvements in the masts, yards, and rigging of ships
2566. B. Stott, Salford, near Manchester—Improvements in machinery or apparatus for preparing, spinning, and doubling cotton, wool, flax, or other fibrous materials
2567. J. Young, Wolverhampton—Improvements in flooring cramps and lifting jacks
2568. J. Parbery, Northampton—Improvements in horse-collars
2569. J. C. Sinclair, Elgin, Moray—Improvements in treating, preparing, and drying agricultural produce
2570. T. A. Cook, Walker Alkali Works, Newcastle-on-Tyne—Improvements in treating manganese ores
2571. J. Warne, Blackfriars-road—Improvements in beer-engines

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2572. J. Stone, Park-terrace, New Cross—Improvements in the construction of force pumps
2573. W. H. Moore, Wenlock-place, City-road—Improvements in railway signals
2574. W. J. Curtis, Sebbon-street, Islington—Improvements in lighting and ventilating railway carriages

Dated November 3.

2575. J. Jobson, Litchurch, Derby—Improvements in the manufacture of railway chairs
2576. S. Tearne and G. W. Richmond, Birmingham—Improvements in producing ornamental designs on the surfaces of fancy and other goods made of papier maché, wood, glass, china, earthenware, tin, iron, or other such like materials, the surfaces of which when made up are usually finished by staining, varnishing, painting or japanning
2577. J. Nasmyth and R. Wilson, Patricroft—Improvements in hydraulic pumps and presses for packing cotton and other articles of the like nature
2578. S. Middleton, Porter-street, Newport-market—Improvements in the manufacture of certain articles of leather without seams
2579. J. White, Glasgow—Improvements in preparing for spinning cotton and other fibrous substances
2581. E. E. Scott, Dundee—Improvements in stereoscopes
2582. W. K. Westly, Leeds—An improved method of, and machinery for, heckling, combing, drawing, and preparing fibrous substances for spinning
2583. A. Kirkham, Tonbridge-place, New-road—Improvements in the construction of furnaces, ovens, or kilns for drying, baking, or burning pottery, earthenware, bricks, tiles, or other similar articles, and in the means of collecting and condensing the smoke, gases, or vapours evolved from the fuel in such or other furnaces or fireplaces, or that escapes from the retorts and other parts of the apparatus used in the manufacture of gas

Dated November 4.

2584. J. Murgatroyd, Stockport—Improvements in machinery or apparatus for spinning, cleaning, doubling, and throwing silk; part of which improvements are applicable to machinery for roving and doubling cotton, and other fibrous substances
2585. H. Bessemer, Queen-street-place, New Cannon-street—Improvements in the manufacture of rails, or railway bars, and axles
2586. E. Campbell, Boston, Massachusetts—A new and useful or improved apparatus for propelling a navigable vessel
2587. W. Gray and J. Tate, Newcastle-on-Tyne—Improvements in apparatus for washing
2588. J. Jessop, West-gate, Bradford—Improvements in machinery for washing, wringing, and mangling
2589. S. Cotton, Broughton, near Manchester—An improved mode or method of regulating or governing lift, tilt, or other hammers worked by mechanical power
2590. W. E. Newton, Chancery-lane—Improved machinery for riming and tapping gas fittings. (Communication)
2591. W. E. Newton, Chancery-lane—Improved machinery for sweeping floors, streets, and walks. (Communication)

Dated November 5.

2592. A. J. I. de Montenay du Minhy, Blois, France—Improvements in screw hand-presses. (Communication from P. Samain, Meusnes, France)
2593. W. Weild, Manchester—Improvements in velvet or cut pile fabrics, and in looms or machinery used for weaving such velvet and other loop pile fabrics
2594. L. Urion, Nancy, France—Improvements in machinery for the manufacture of matches and match-boxes
2595. W. E. Wiley, Great Hampton-street, Birmingham—Improvements in pen-holders
2596. C. Titterton, Rochampton, Surrey—Improvements in the manufacture of zinc and zinc white
2597. J. Fernihough, Dukinfield, Chester, and R. Farrow, Leek, Stafford—A self-acting apparatus for regulating the supply of atmospheric air to furnaces, gas stoves, and other closed vessels used for the consumption of fuel or combustible gases, by preventing the formation of smoke therefrom, and thereby economising such fuel or combustible gases
2598. W. E. Newton, Chancery-lane—Improvements in steam engines. (Communication)
2599. W. Clissold, Dudbridge, Gloucester—Improved apparatus for regulating the supply of water to water-wheels
2600. H. Keeling, Rotherhithe, Surrey—An improvement in rivetting fish joints and other parts of the permanent way of railways
2601. H. Hill, Stepney—An improvement in locks for bags and other like articles
2602. W. Brindley, Moorgate-street—Improvements in the preparation of paper hangings and other ornamental papers
2603. R. W. Sievier, Upper Holloway—An improvement in the mode of treating saccharine juices in the manufacture of sugar
2604. J. Stanley, Whitechapel-road—Improvements in the construction of, and mode of applying, cranes and other machines for hoisting, suspending, and lowering purposes, also in generating, transmitting, and applying motive power to the same
2605. W. Seed, Preston, and W. Ryder, Bolton-le-Moors—Improvements in certain parts of machinery for slubbing and roving cotton and other fibrous materials
2606. F. Holdway, Bayswater—Improvements in the manufacture of candles
2607. W. Blackwell, Settle, York—Improvements in ploughs
2608. M. Browne, Strand—Improvement in shirts
2509. G. Collier, Halifax—Improvements in drying, stretching, and polishing or finishing yarns

Dated November 6.

2610. G. H. Stevens, Stafford-row, Pimlico, and R. Fitch, South Lambeth—Improvements in locking and unlocking jars, bottles, and other vessels, and making such vessels air-tight
2611. J. La Cabra, Albany-street—Improvements in the action of pianofortes
2612. C. Hunter, Islandreagh, Antrim, Ireland—Improvements in effecting the operations of drying, heating, and ventilating
2613. J. Parker, Blackburn—Improvements in machinery or apparatus for roasting coffee, or for other similar purposes
2614. W. H. Olley, Brabant-court, Philpot-lane—Improvements in obtaining photographic impressions of pictures of microscopic objects
2615. J. Webster, Birmingham—A new or improved instrument or apparatus for transmitting hydrostatic and pneumatic pressure, which said instrument or apparatus is applicable to pressure gauges, safety-valves, thermometers, and other like machines
2616. P. Cato, J. Miller jun., and J. Audley, Brunswick Dock, Liverpool—Improvements in the manufacture of ships' knees'
2617. R. A. Brooman, Fleet-street—Improvements in the manufacture of cranked axles and shafts. (Communication from C. Russery)
2618. F. Chapman, Piccadilly, and C. Bowyer, Davies-street—A method of purifying and disinfecting intestines, and manufacturing gelatine therefrom

Dated November 7.

2619. H. Dircks, Moorgate-street—Improvements in the preparation and application of the materials for making worts and washes in brewing, distilling, and like operations, and in the apparatus connected with the same
2620. A. Porecky, Hackney—Improvements in the construction of safety match or lucifer boxes
2621. T. Ollis, jun., Liverpool—Improvements in machinery or apparatus for cutting paper, card-board, mill-board, scale-board, leather, and other substances of a light nature
2622. W. Spence, Chancery-lane—Improvements in apparatus used in the manufacture of silk and other fibrous materials. (Communication from J. L. A. Aubenas, Valréas Vaucluse, France)
2623. J. L. Casartelli, Manchester, and A. Casartelli and L. Casartelli, Liverpool—Improved apparatus for ascertaining the density of water in marine steam boilers or generators, for the purpose of preventing saline incrustation
2625. L. J. V. Vaitton, Paris—An improved apparatus for consuming smoke

Dated November 8.

2626. J. Dickinson, Blackburn—Improvements in machinery or apparatus used in the preparation of cotton or other fibrous substances for spinning
2627. G. Bertram, Edinburgh, and W. McNiven, Polton Mill, Lasswade—Improvements in the manufacture of paper
2628. L. Huxtable, St. Michael's Hill, Bristol—Improvements in pianofortes
2629. W. Porter, Lansdowne Villas, Brompton—Improvements in the grinding of cements, and other substances, and in the construction of millstones for the same
2631. C. Vaughan, J. Vaughan, and R. Vaughan, Birmingham—A new or improved strap or band for working stamps, raising weights, and transmitting power generally
2632. A. Reid, Sidmouth-street, Regent-square—Improvements in treating iron so as to render it impervious to continuous oxidation
2633. W. Morphet, Leeds—Improvements in producing the velvet pile and Witney finish in cloths, and in machinery or apparatus for the same
2635. J. B. E. V. Alaux, Rue St. Étienne, Bonne Nouvelle, Paris—A lubricating composition
2636. T. Walker, Balderstone, Rochdale—An improved method of lubricating the interior of the cylinders of steam-engines for reducing the friction of the pistons thereof
2637. R. A. Brooman, Fleet-street—Improvements in preserving provisions. (Communication from Garnier, Brothers, Faucheux, Tisse, and Co.)
2638. R. A. Brooman, Fleet-street—Improvements in machinery for cutting and dressing stone, marble and similar materials. (Communication)

Dated November 10.

2639. H. Bessemer, Queen-street-place—Improvements in the manufacture and treatment of iron, and in the manufacture of steel
2640. E. T. Dolby, Stratrord-place, Camden-town—Improvements in printing several colours at one time from a single stone, plate, or block
2641. A. Barlow, Shirley, Hants—Improvements in washing apparatuses
2642. F. J. Manceaux, and E. N. Vieillard, Paris—An improvement in breech-loading fire-arms and ordnance
2643. W. Stones, Greenhithe, Kent—An improved mode of sizing paper
2644. P. Gaskell, Sculcoats, Kingston-upon-Hull—The admission of steam into the cylinders of steam-engines by an equilibrium valve.
2645. J. Somerville, Glasgow—Improvements in weaving
2646. J. H. Johnson, Lincoln's-inn-fields—Improvements in apparatus for printing electro-telegraphic dispatches. (Communication from L. F. C. Breguet, Paris)
2647. R. Pearcy, Manchester—Improvements in machinery or apparatus for giving additional cohesiveness and torsion to fibrous substances in the drawing and other processes

Dated November 11.

2648. W. Smith, Salisbury-street, Adelphi—Improvements in machinery for sewing cloth and other materials. (Communication from E. Howard, Massachusetts)
2649. J. T. Jones, Birmingham—Improvements in the manufacture of rollers or cylindery for printing fabrics, and in machinery to be used in manufacturing the said rollers or cylinders
2650. W. Clark, Chauncery-lane—Improvements in the manufacture of barytes and strontian, and their salts, and in their application to various purposes. (Communication)
2651. R. A. Brooman, Fleet-street—Improvements in the manufacture of boots and shoes, and other like articles. (Communication from N. Gaillard, Paris)
2652. J. Leadbetter, Leeds—Improved means of obtaining motive power
2653. F. F. Closeman, Park-lane—Obtaining alcohol from certain substances not hitherto used for that purpose. (Communication)
2654. P. R. Hodge, Albion-grove, Barnsbury-park—Improvemen[illegible]he manufacture of felted cloth. (Communication)
2655. H. Bains, Manchester—Improved machinery or apparatus to be applied to hoisting and other lifting machines
2656. J. H. Johnson, Lincoln's-inn-fields—Improvements in projectiles. (Communication from G. M. Hutton, Vice-Consul for the United States at St. Petersburgh)
2657. J. Bernard, Albany, Piccadilly—Improvements in the manufacture or production of boots and shoes, or coverings for the feet, and in the machinery or apparatus employed in such manufacture

Dated November 12.

2659. W. Lukyn, Broad-street, Nottingham—A buffer break for railway carriages or trucks attached to locomotive engines, whether one or more engines, for the conveyance of goods or passengers
2661. W. Weild, Manchester—Improvements in machinery for doubling, twisting, and winding yarns or threads on to bobbins or spools
2663. H. Collett, Grosvenor-street, St. Peter's-street, Islington—Improvemen[illegible]s in machinery for mowing and reaping
2665. A. Maw, Broseley, Salop—An improved mode of constructing the eccentrics or cams of steam-engines and other machinery
2667. J. C. Boulay, Rue des Bernardins, Paris—An improved method of printing in various colours simultaneously
2669. R. A. Brooman, Fleet-street—A new or improved felted fabric. (Communication from F. Durand)
2671. W. Green, jun. Framwell Gate Colliery, near Durham, and T. Storey, Durham—Improvements in machinery or apparatus for washing or cleaning coal

Dated November 13.

2673. T. W. G. Treeby, Westbourne-terrace Villas, Paddington—Forming sewers or tunnels, and gulleys to sewers
2675. A. Hutton, Ardwick, near Manchester—An improved warming apparatus, applicable to railway and road carriages, and other useful purposes
2677. S. Newington, Ticehurst, Sussex—Improvements in dibbling apparatus
2679. W. Francis and J. Hooper, Leadenhall-street—Improvements in tanning and dyeing leather, linen, cotton, wool, hair, silk, and fabrics composed of any of these substances

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PATENT APPLIED FOR WITH COMPLETE SPECIFICATION.

2720. W. Healy, Dorset-street, Salisbury-square—Improvements in furnaces and boilers and hot-water apparatus for heating purposes.—November 18

END OF VOLUME XIX.

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